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# SOME ASPECTS OF URBAN MAPPING
# EDMONTON AND HYDERABAD

by

© MOHAMMED AHMED

A THESIS

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Some Aspects of Urban Mapping - Edmonton and Hyderabad," submitted by Mohammed Ahmed in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

This study is concerned with the identification and description of urban cartographic techniques as applied to two cities, one of which is located in a developed region of the world (Edmonton, Canada), and one in a developing region (Hyderabad, India). The comparison of cities with such marked morphological and historical differences offered a greater range of cartographic problems than would occur if only one city were to be studied. The comparisons were made in the context of the history of urban maps, the utility of urban maps, and the methods of cartographic presentation and reproduction.

The comparative approach resulted in a number of difficulties regarding the collection of comparable examples of cartographic solutions for the two cities under study. In spite of these difficulties the comparisons provided insights into the particular problem of dealing with a great range of urban features from the qualitative and quantitative points of view. The need for greater standardization of cartographic symbols was recognized from these comparisons. Because of the great differences in densities of activities between the two cities, careful consideration of symbol selection is essential.

The urban cartographer can choose from some eight different methods of portraying urban data. The actual method used depends on the nature of the data to be portrayed and the facilities available for the reproduction of the finished maps. The comparative approach revealed that although great advances have been made in such areas as computer mapping and map reproduction, their practical application is very limited in developing nations. The urban cartographer must be continually aware of new developments in urban data collection, cartographic representation, and reproduction, but must also operate in the context of the facilities and resources available. Knowledge of urban features is desirable and close collaboration with those urban specialists who use urban maps is essential.

ACKNOWLEDGMENTS

First and foremost I would like to express my sincere thanks to Prince Muffakham Jah and Dr. S. Manzoor Alam for helping me to undertake a programme in cartography at the University of Alberta, Canada. I am also thankful to the Chairman and other trustees of H.E.H. The Nizam's Charitable Trust for the financial assistance I received in the beginning of this study.

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I extend my thanks to the cartographic staff of this department for providing all necessary facilities and printing of the maps, particularly Mr. Geoff Lester and Mr. Jack Chesterman. Finally, I thank Mrs. Laura Smith for her careful and neat typing of this thesis.

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*"One way or other, maps find their use in all spheres of scientific, economic and cultural activities. They are indispensable for a detailed registration, analysis and objective evaluation of natural conditions and resources, labour resources and productive forces, as well as of the multiform service system (education, public health services, trade, etc.). On the basis of maps, projects are worked out for reasonable utilization and reproduction of natural resources, transformation of natural environments and prognoses for their alteration. They are used for ruling over a state and controlling its economy, they serve the purposes of planning rational distribution of productive forces, which ensures the saving of material, labour and financial resources. Great is the role of maps in national education and in general advance of culture. Maps show natural conditions, population and political systems of individual countries and of the world as a whole, thus serving the purpose of mutual acquaintance and, hence, mutual understanding between nations."*[1]

*-Konstantin A. Salichtchev-*

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[1] "The Present Day Thematic Cartography and the Task of International Collaboration." Institution of Surveyors, (India). New Delhi: 21st International Geographical Congress, New Delhi, Nov.-Dec. 1968, pp. 7-8.

# CHAPTER I

## INTRODUCTION

Maps are a means of communication, used for a variety of purposes by the people living within cities and other areas. They play an important role not only in ordinary city life,but all other consequential decisions are made in both peace and wartime on the basis of evidence supplied through maps. Cities, as seats of authority, and centres of specialized activity occupy a distinctive position in the life of human beings. In order to seek better economic opportunities for social or cultural change, people move into cities from rural areas. Recently, the rapid growth of cities and expanding urban problems have become topics of vital concern throughout the world. These are consequences of modern urbanization, a process which not only constitutes or shapes new cities, but modifies the size and function of old cities. As a result cities are now confronted with increasing populations, high densities, insufficient natural resources, inadequate infrastructures, poor hygienic conditions, and sprawling areas. These con-

ditions are likely to continue in the coming years, as Jacobs[1] has predicted:

> ... "We can be absolutely sure of a few things about future cities. The cities will not be smaller, simpler or more specialized than cities of today. Rather, they will be more intricate, comprehensive, diversified, and larger than today."

Considering the seriousness of these problems and the future trends of cities, urban planning now deserves greater attention than ever before. This is quite evident from the numerous studies and the voluminous literature recently published on urban affairs and urban planning.

While urban planning does not provide definite solutions to the problems, it does suggest through systematic analysis how desired objectives can be accomplished by taking into account available resources and social needs. Normally, the objectives include balanced urban growth and better use of natural resources, based upon studies of population growth and distribution. Such planning also takes into account land use patterns, environmental conditions, and functional relationships between cities and their neighbouring areas. Studies of such complex phenomena involve the participation of many specialists. For these studies, maps with specific details are required for the inventory of resources, analysis of areas,

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[1] Jane Jacobs, The Economy of Cities. New York: Random House, 1970, p. 250.

identification of problems, prediction of trends, and pre-preparation of future plans. Maps are the graphic media through which this information is provided in a concise and classified form. They enable the specialists to observe, compare, analyze and correlate various forms and patterns within cities and their neighbouring areas. Furthermore, maps serve as an efficient means of communication between specialists, authorities and citizens, each of whom has a varied level of understanding.

The need for maps varies from one person to another. Government authorities require maps for assistance in the administration of cities, urban specialists employ them in studies of urban planning, and citizens and tourists need them for locating places of interest. Maps are thus important to all people associated with cities and play a significant role in planning and development of cities.

Urban mapping is concerned with the preparation and production of maps, diagrams and map-like sketches. This involves the collection and processing of data, selection of scales and projections, symbolization of data and cartographic design, as well as the construction and production of finished maps. Urban maps carry information representing past, present, and future conditions of cities. They are usually prepared at large scales and are published under specific themes.

## A. Purpose of Study

Urban mapping, while an ancient practice, is in the process of change from its traditional methods of production to modern techniques. In the past, the construction and reproduction of maps involved a considerable amount of time and manpower. But recent technological developments and the introduction of new mapping techniques are revolutionizing the old processes. For example, aerial photographs, computers, stereo-plotting machines, and sophisticated printing presses have enabled the rapid production of urban maps to keep pace with the increased demand.

Despite these advances, continued urban growth and increasing urban problems are creating an even greater demand not only for more maps but for further improvement in the quality of graphic images. This necessitates more studies to improve the quality and speed of production. Moreover, there are significant differences in the mapping capabilities of various countries of the world. The differences are significant not only in terms of technological levels, but also because their urban problems and mapping needs are varied.

With these considerations in mind, this study is an attempt to investigate various aspects of urban mapping with reference to urban patterns of two rather different cities - Edmonton and Hyderabad. All graphic illustrations are confined to the examples of urban phenomena which re-

late to these two cities.

## B. Literature Review

Literature on urban mapping, particularly in the English language, is sparse, except for the occasional paper appearing in journals or yearbooks. This is because the period of specialization and subdivision of subjects within the main field of cartography is a recent phenomenon:

> ... "Urban cartography is still quite a young science. It emerged for the first time after the World War and consolidated itself in the past 10-15 years. This again is the period in which the phase of rebuilding the town had been finished. After this a systematic town-planning was initiated with the intention to create the suppositions with regard to an organized and reasonable development of all life and work within the town."[1]

For this study, five main sources of information have been researched: (1) books, (2) journals, (3) yearbooks, (4) atlases, and (5) special publications.

There are numerous books about the growth, problems, and planning of cities, but few on cartography, and only one, to the author's knowledge, on urban mapping. Cartography books specifically deal with general aspects of surveying and mapping under such titles as General Cartography, Principals of Cartography, Elements of Cartography, Mapping, Maps and Diagrams, Maps and Air Photographs,

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[1] Heinz Pape, "Urban Cartography - Town Planning." International Yearbook of Cartography, 1973, p. 192.

Statistical Mapping and Presentation of Statistics, Cartographic Methods, Cartography, Cartographic Design and Production of Maps,[1] etc. Some of them have given greater importance to a specific topic only and a few have dealt with all related aspects such as data sources, construction, and reproduction of maps. For instance, the first four titles mentioned have dealt with all aspects of mapping, and the remaining have not dealt with either map projection or reproduction. However, all these books provide basic knowledge about cartography as a basis for their topical approaches.

Journals of cartography, geography, and other closely associated subjects are important sources dealing with specific topics, particularly urban mapping. In the past, geographical journals contained essays concerning both cartography and geography. Cartographic journals and yearbooks began to appear only within the past 10 to 15 years. Even now there are only a few: Cartography (Australia), American Cartographer, Canadian Cartographer, and The Cartographic Journal (United Kingdom), all published twice a year. In other countries essays on cartography still appear in the geographic journals or other journals such as Erdkunde, Land Economics, Ekistics, Penrose, and so on. A search has been made in both cartographic and

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[1]See Bibliography.

geographic journals for information relevant to this study.

The only cartographic yearbooks are World Cartography and the International Yearbook of Cartography, published by the U.N. (United Nations) and I.C.A. (International Cartographic Association), respectively. The I.C.A. books have been a valuable source of information for this study.

The enlarged inset maps of cities shown in atlases have been helpful in two ways: first, they provide ideas regarding the areal expansion of cities, and secondly, they show various methods of representing selected information at much smaller scales.

Special proceeding publications of national and international conferences such as the "Plan" (National Conference on Urban Surveying and Mapping, 1971, Toronto, Canada), and the I.G.U.'s (International Geographical Union) publications (1968 and 1972 Congresses) have been extremely useful.

## C. Organization and Procedure

This thesis has been prepared on the basis of library research, using information gathered from published sources only. The cities of Edmonton and Hyderabad were chosen because of the similarities in their spatial distributions, such as locations of rivers, C.B.D. (Central Business Districts), airport, and industrial areas, despite

significant differences in their histories and present urban patterns.

The thesis is divided into six chapters. The first chapter gives an outline of urbanization, urban problems, planning and mapping requirements. In the second chapter, historical development and trends of world urbanization are presented. The impact of historical events on the growth and development of Edmonton and Hyderabad and variations in their urban patterns are also brought to light. The third chapter focuses on the need for maps, the historical development of maps, and the role of maps in planning and daily city life with reference to Edmonton and Hyderabad. The various types of maps, such as base maps, general purpose maps, and special purpose maps are also discussed. The fourth chapter includes basic problems of map construction such as collection and processing of data, selection of scales and projections, symbolization of data and cartographic design. The existing difficulties in the standardization of symbols at the global level have been discussed, with specific reference to dissimilarities in the railroad symbols used on Edmonton and Hyderabad maps. The types of information required for the construction of different urban maps are also discussed. The fifth chapter shows the appropriate application of cartographic methods to various types of similar phenomena in the two cities. In this chapter, reproduction methods for the final maps are also discussed briefly. Finally, in

the sixth chapter, after providing a summary of the thesis, the difficulties in getting data and ascertaining the state of mapping in Edmonton and Hyderabad are discussed by way of conclusion.

## CHAPTER II

## HISTORICAL DEVELOPMENT OF CITIES

Cities are probably the most important expression of human occupancy on the earth's surface. Besides being the home for their citizens, they are seats of authority, major collection-distribution centres, and focal points for a number of other important activities. Due to their functional characteristics, they have internal and external relationships between themselves and their neighbouring areas. In the past, they were built at places of strategic importance or convenient trading posts, and developed as centres of governmental, commercial and manufacturing/ industrial activities.

Until two centuries ago, all cities in the world were pre-industrial, few in number, small in area, and sparsely populated. By contrast, modern cities have appeared as a consequence of the industrial revolution and have developed around places of raw materials, industrial complexes, and market centres. Industrial cities exhibit a

high degree of specialization in their functions and tend to have large areas as well as dense populations. In the past few decades, technological developments, improved means of transportation, and better economic opportunities have paved the way for an accelerating rate of urbanization. All over the world, there has been a rapid increase of urban populations in both pre-industrial and industrial cities. As a result, most cities are over-crowded, their areas are sprawling, and they face many problems. Life in many urban areas has become uncomfortable or degraded, and urban conditions are still deteriorating, which is evident from the current literature published in this regard.

The efficient functioning of cities is closely associated with the number of inhabitants, available facilities, and stock of resources. An increase in urban population not only exerts pressure for more urban facilities, but it also creates disorder in the existing amenities. According to the United Nations population projections, the increase in urban population is likely to continue in the coming years, as shown in Figure 2.1.

It is important to note that the present projection of urban populations in the less developed regions is higher than in the more developed regions of the world. This implies that the less developed regions should pay more attention to urban planning than the more developed regions. It can, therefore, be said that these regions

# WORLD
# URBAN POPULATION

(Projections — 1970-2000 A.D.)

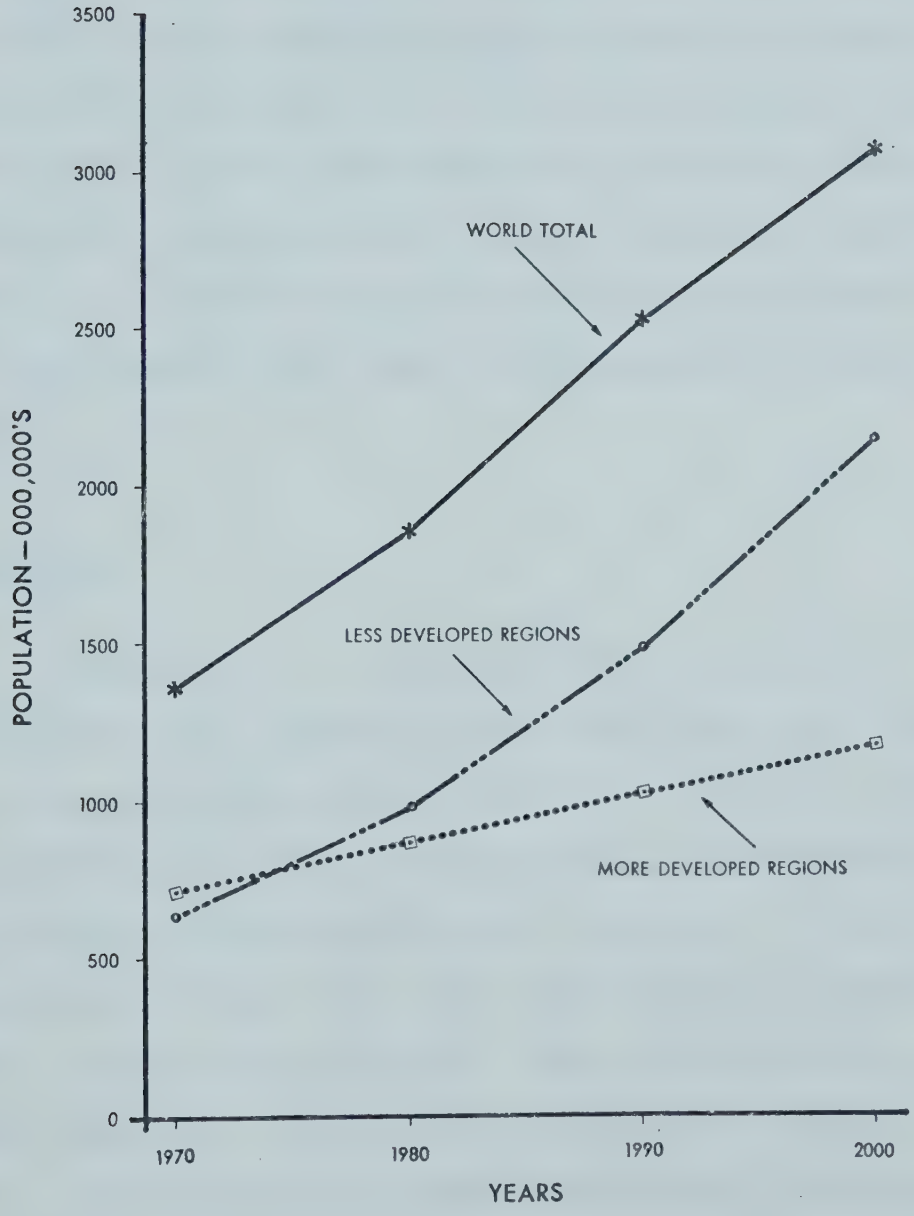



Figure 2.1

differ significantly not only in their urban populations, resources, and urban problems, but also in their mapping requirements.

In the development of cities, historical events play a vital role. Often planned cities later appear unplanned due to their age, and due to political events and events leading to a scarcity of resources. Therefore, while dealing with aspects of urban mapping an attempt has also been made to bring into view the influence of historical events in the development of two cities, Edmonton and Hyderabad, lying in two different regions of the world (Figure 2.2). A brief historical background of these two cities will preface the later considerations of urban mapping.

## A. Edmonton

Edmonton is the capital of the province of Alberta, and is the seventh largest city in Canada (1971). It is located on the wide and impressive valley of the North Saskatchewan River, 54°N latitude, 113°W longitude, lying between 650-700 meters above sea level. It has an invigorating climate with a mean temperature in summer of 17°C and a winter mean of 11°C. The city gets a dry snowfall that averages 178 mm, and a rainfall of 4700 mm annually. Before 1795 the Edmonton area was a wilderness where the Wood-Cree Indians roamed and hunted bountiful

LOCATION OF

# EDMONTON AND HYDERABAD

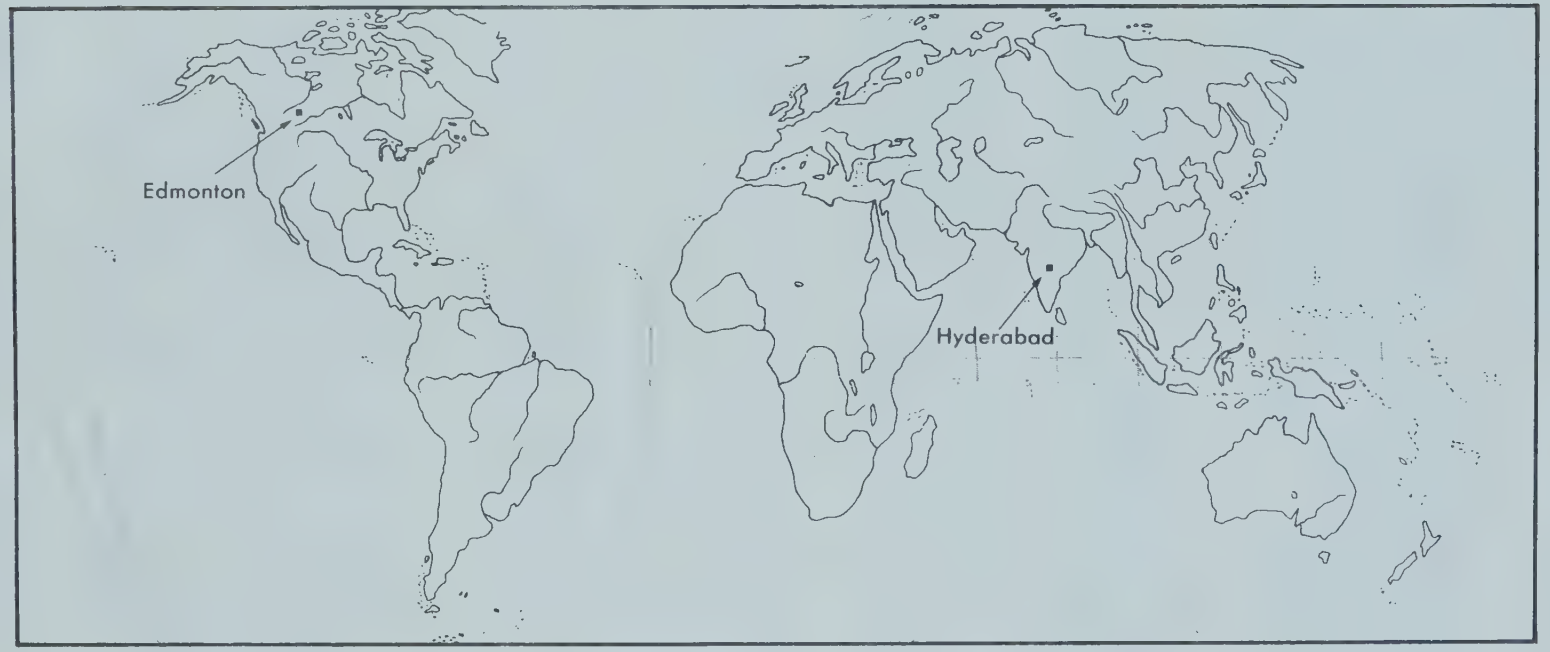



Figure 2.2

wild game. The fur potential of the Edmonton area brought early French fur traders to the North Saskatchewan River. According to MacGregor:[1]

> "Some 10,000 years ago Indians began to work their way into this region, they found it congenial. For hundreds of generations they roamed its forests, having neither inkling of what might be done with this soil nor knowledge of the vast stores of energy beneath their camp fires.
>
> ... the first white men came strolling in to see what the area might offer. With their nose for natural resources and their devastating ability never to let well enough alone, they began to develop its riches.
>
> ... in 1795, on the north bank of the great Saskatchewan River, fur traders erected Edmonton House. Set in the midst of such resources, Edmonton was bound to become a great city."

Edmonton House (Fort), a fur trading post, was first built by William Tomison, an employee of the Hudson Bay Company. The first fort was destroyed by the native Indians in 1807, and later in 1820, a large fort was again constructed, at which time it started growing as a trade centre.

In these early days, missionaries, particularly Father Lacombe, contributed much to the growth of the Edmonton area. The use of Red River Carts was also a great aid in bringing people to this area. Eventually, in 1891, Strathcona village, situated a mile south of the

---

[1] J.G. MacGregor, Edmonton - A History. Edmonton: Heritage Publishers, 1975, (book cover).

river opposite to the Edmonton area, was connected with Calgary to the south by the Canadian Pacific Railway. In the early days, both Edmonton and Strathcona were competing to be the major settlement in the area, but ultimately Edmonton prevailed and was declared a town in 1892 with a population of 360 persons.

Edmonton had rapid growth between 1896 and 1898, when thousands of people who attempted the overland route to the Klondike gold fields in the Yukon area turned back to settle there.

In 1904, Edmonton was incorporated as a city, and in 1905 it was selected as the capital of the newly formed province of Alberta. That same year, the city was linked to other parts of the country, i.e., to eastern Canada and to the west coast by the Canadian Pacific Railway.

In 1912, the amalgamation of Edmonton with Strathcona ended the rivalry between the two settlements and the population increased to 30,679 persons, with an area of 60.11 $km^2$. This spectacular increase in population continued till 1914, when, during World War I, the city had a decrease in its population. Even after the war, the growth was slow until 1947. At that time oil was discovered at Leduc, located 34 km. south of Edmonton, and since then Edmonton has rapidly grown as a leading industrial and resource centre.

At present Edmonton has reached the status of a metropolitan city and is functioning as an important regional centre in the western part of Canada. The graph in Figure 2.3 shows decennial growth of the city since 1901.

B. Hyderabad

Hyderabad is the capital of the state of Andhra Pradesh, and is the fifth largest metropolis in India (1971). In 1591, the city was founded by the fifth ruler of the Qutub Shahi Dynasty, Mohammed Quli Qutub Shah. The city is located on the south bank of the Musi River, 17°N latitude and 78°E longitude, lying between 550 and 600 meters above sea level. It enjoys a healthy climate with average maximum and minimum temperatures of 43°C and 10°C. The average annual rainfall is 7500 mm, most of which occurs during the monsoon period (May to October). The city was initially planned on a grid pattern around the historical 'Charminar' (a monument having four minarets), which was considered the city centre. During its three hundred and eighty-five year history, the city's growth has not been continuous, due to a number of political events. By considering the most significant political events, Alam[1] has

[1]S. Manzoor Alam, Hyderabad-Secunderabad, A Study in Urban Geography. Bombay: Allied Publisher Put. Ltd., 1965, p. 2.

# EDMONTON
# URBAN POPULATION AND AREA
## 1901—1971

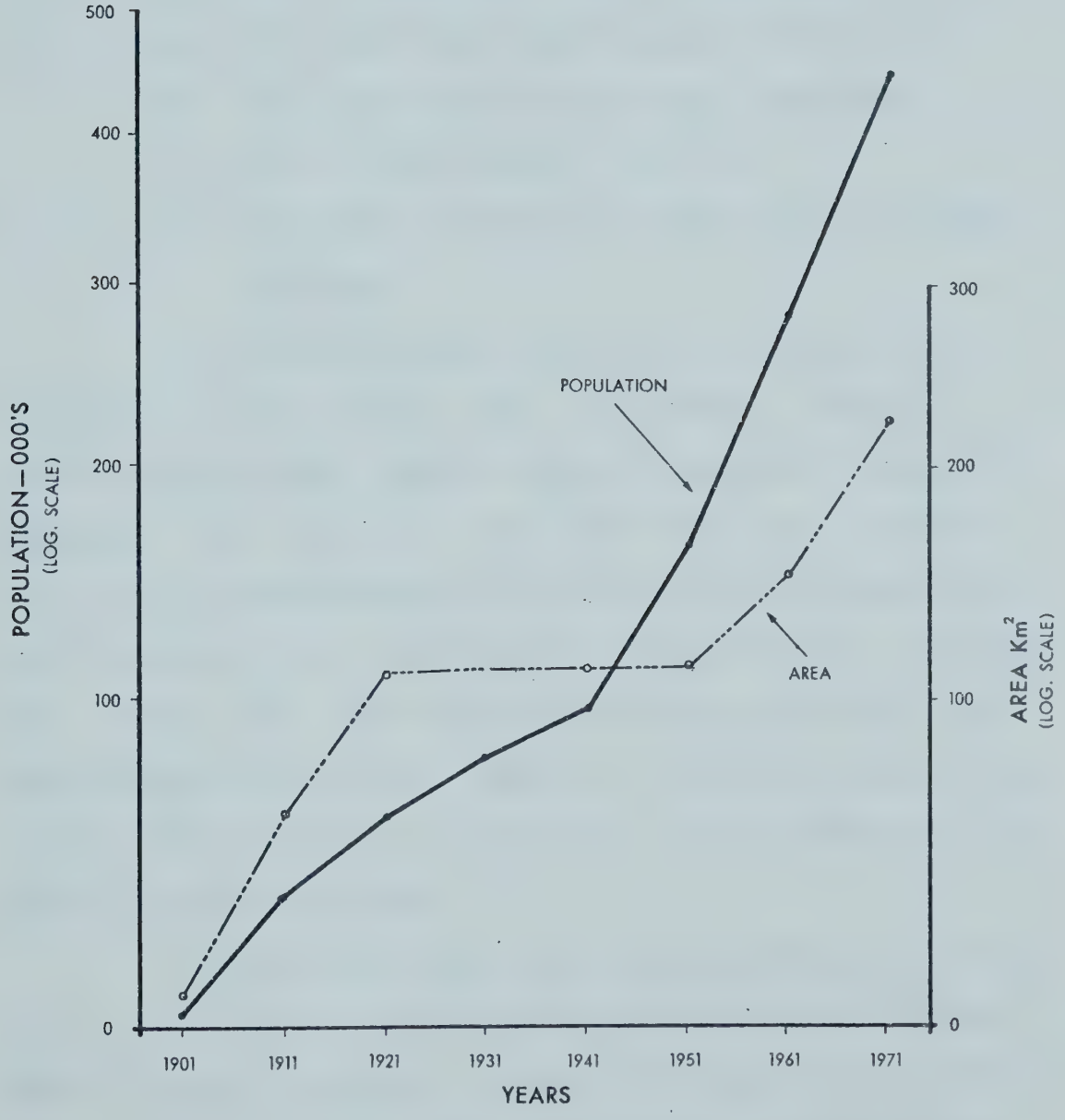



Figure 2.3

divided the growth of Hyderabad into six stages from its inception to the present time. For convenience, the same stages are considered in this study.

I - Qutub Shahi Stage, or First Twin City Stage, 1591-1687

II - The Transitional Phase, 1688-1725

III - The Early Asaf Jahi Period, 1725-1799

IV - The Second Twin-City Stage, 1799-1874

V - The Railway Stage, 1875-1908

VI - The Modern or Metropolitan Stage, from 1908 onwards.

In the beginning, Hyderabad was considered a successor to the fortress town of Golconda, the early capital of the Qutub Shahi Kingdom, situated 7 km west of Hyderabad. The king Quli Qutub Shah took an interest in the plan and development of the city and as a result many royal palaces, public buildings, and gardens were constructed. People were also encouraged to move into the city from neighbouring areas. Hence, in the first stage of its history, Hyderabad had a phenomenal growth because of its better living conditions.

During the second stage, Hyderabad's growth was hampered due to the fall of Qutub Shahi Kingdom into the hands of Moghal Emperor. In 1688, the seat of authority was shifted from Hyderabad to Aurangabad, 750 km to the northwest of the city. As a result, Hyderabad lost its

importance, and the city had a period of transition during the years 1688 to 1725.

In 1725, the political power changed, and under a new dynasty Hyderabad was selected as capital of the Asaf Jahi Kingdom. Soon after, the city began growing again as a seat of authority, with the return of nobles and civil servants. Growth continued during the early Asaf Jahi period (1725-1798).

In 1798, Secunderabad, located 8 km to the north of the 'Charminar', was given to the East India Company (the British trading company) as a residence for the company's military forces. As a regional base for the company's forces, Secunderabad's growth was rapid and soon it reached the status of a city. Thus, during the fourth stage, 1799-1874, Hyderabad and Secunderabad continued to grow as twin cities with significant differences in their functional characteristics under two different authorities.

In the fifth stage, 1875-1908, both Hyderabad and Secunderabad were connected by the railway with other major cities of India. This encouraged the growth of industries, and as a result many industrial establishments began appearing within and around the cities.

In the sixth stage, from 1908 to the present time, Hyderabad has experienced natural calamity, political change and significant variation in its population. In 1908, a major part of the city, built on the flood plains of the Musi River, was washed away by a flood which took many

lives and caused great property damage. On the other hand, this calamity gave momentum to the need for a planned development of the city. Under Asaf Jahi VII, the last ruler of the Asaf Jahi Dynasty, a rebuilding of Hyderabad was started and the city experienced significant progress in all areas of urban life until 1947, when the kingdom merged with the Indian Union.

In 1956, all states in India were reorganized on the basis of regional languages. Fortunately for Hyderabad, the city remained as the capital of the newly formed Telugu speaking State of Andhra Pradesh. Since this time, the city's growth has been most spectacular, as expressed by its change in functional character, i.e., from a pre-industrial to an industrial city.

In 1960, the amalgamation of Secunderabad into Hyderabad was another significant event, and this increase in population and area has made Hyderabad one of the largest urban areas in India. The graph in Figure 2.4 indicates the decennial growth in population since 1901 to 1971.

## C. Comparison of Edmonton and Hyderabad

The following facts have been noticed when comparing the historical events of the two cities:

(1) Both have grown due to the importance of their geographical locations,

(2) Means of transportation and better economic

# HYDERABAD
# URBAN POPULATION AND AREA
## 1901—1971

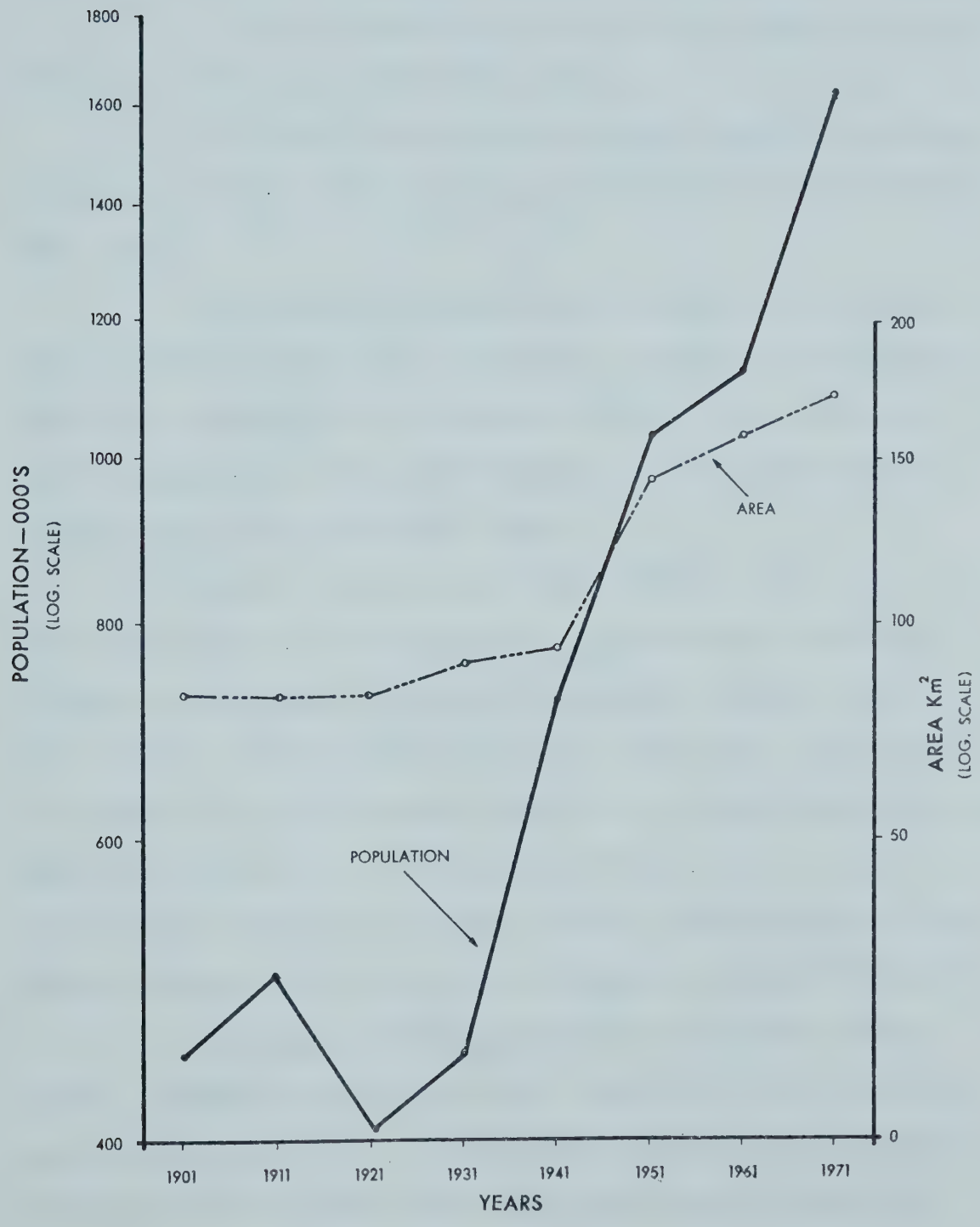



Figure 2.4

opportunities had a greater significance in the early growth of Edmonton than in Hyderabad,

(3) Hyderabad's growth, more than Edmonton's, is due primarily to its importance as the capital of a state,

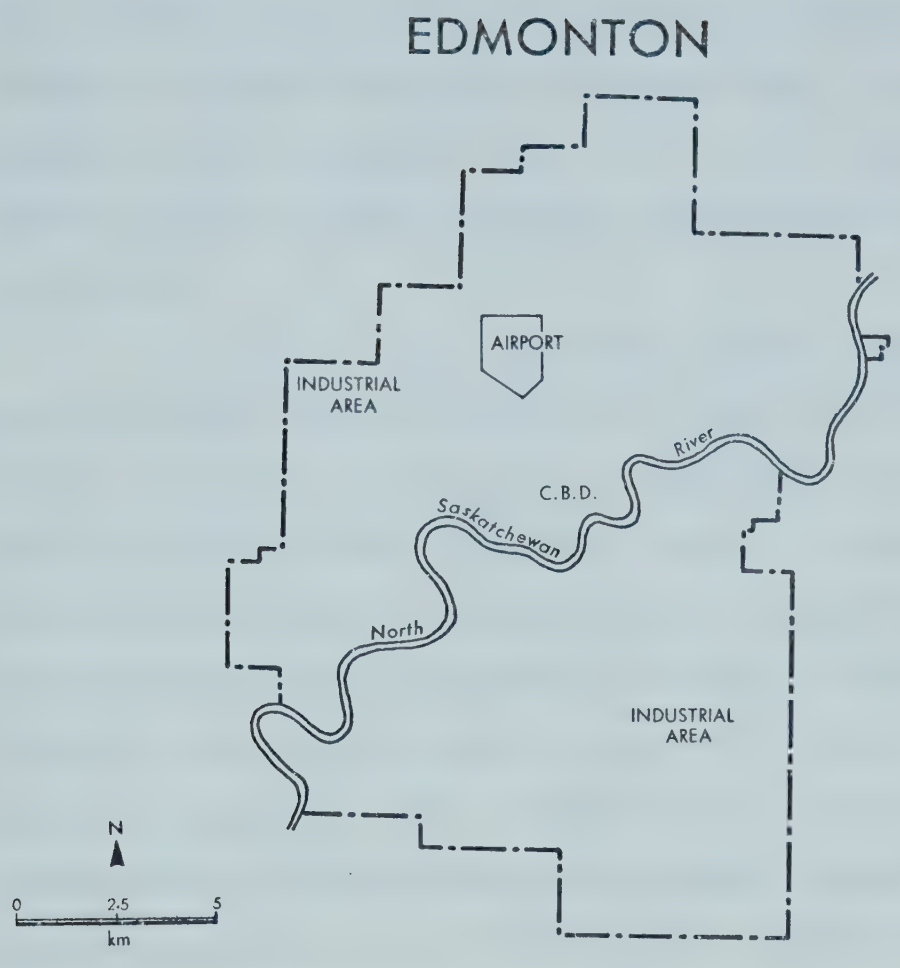
(4) The morphology of both cities represents the impact of numerous historical events,

(5) Relatively stable political conditions have resulted in fewer urban problems in Edmonton than in Hyderabad, and

(6) Edmonton's planning problems are involved, more or less, with future expansion, whereas in Hyderabad the major tasks of city planning include, in addition to future expansion, the redevelopment and reorganization of various existing functional areas.

It is interesting to note that in spite of different physical environments, geographical locations, cultural practices, and varied histories, these cities have several spatial similarities. These are: location on rivers, central business areas, and airport locations, as shown in Figure 2.5. Another significant fact is the 'twin city' character in their pasts. Nevertheless, their present urban conditions and problems are quite different.

The city of Edmonton has had an upward urban growth (except during World War I) which is free from any foreign interventions. Consequently, most of the city's problems are concerned with the expansion of areas and improvement in urban services. In contrast, Hyderabad has


EDMONTON
AIRPORT
INDUSTRIAL AREA
River
C.B.D.
Saskatchewan
North
INDUSTRIAL AREA
N
0
2.5
5
km


HYDERABAD
INDUSTRIAL AREA
AIRPORT
INDUSTRIAL AREA
INDUSTRIAL AREA
C.B.D.
River
Musi

Figure 2.5

had discontinuous growth and disturbed political conditions. Although initially a planned city, it could not continue on the original lines. As a result, the city appears partly planned and partly unplanned with a number of problems.

In view of the accelerating urban growth and related problems, urban planning in general is now receiving greater attention. Such planning suggests solutions for urban problems through systematic studies of phenomena and the analysis of areas. Urban planning contemplates the physical growth and development of cities in consideration of their resources and social needs. The field of urban planning encompasses many disciplines and involves the participation of specialists; for example, geographers, historians, economists, sociologists, planners, engineers, architects, cartographers and administrators. In order to develop the planning objectives, these specialists describe the phenomena through observations, measurements, and classifications. They then attempt to predict future trends through reasonable explanations. At each of these three stages, i.e., description, explanation, and prediction, maps are required for a variety of purposes. Maps are essential tools for specialists in their studies of urban phenomena. Besides this, maps play an important role in daily urban life, since authorities use them as a means of communication and the public refer to them as convenient sources of information.

# CHAPTER III

## DEVELOPMENT, NEED AND TYPES OF URBAN MAPS

### A. Development of Urban Maps

Urban mapping has reached a high level of efficiency, and urban maps are serving the needs of a variety of people to a greater extent than ever before. Initially, map making was a means of satisfying the essential needs of primitive people to describe, and thereby cope with, spatial features of their environments. According to available records, the Eskimos of the Arctic and Bedouin of the Arabian Deserts produced crude maps to locate hunting grounds, places of tribal-gathering, and important routes. These simple functions have since been multiplied and are now used in the analysis and understanding of complex urban entities. The development of maps has a long history:

> "If even primitive races are capable of making geographical maps, we may be sure that map-making was practiced by those peoples of antiquity who possessed a high degree of civilization and their own literature, and who were no strangers to the mathematical and astronomical sciences and to technology. In these ancient and highly organized empires, maps served specific purposes and thus were functional or thematic in character: military

> maps, cadestral plans for land-registration, route maps for merchants, and so on."[1]

From this historical statement we can assume that the early civilized nations were able to produce improved maps, having developed the above-mentioned abilities. The need for thematic maps was also realized, and accordingly, cadestral maps and route maps were prepared. These early civilized people inhabited the mighty empires located close to and east of the Mediterranean Sea. The Egyptians, considered to be the inventors of geometry, introduced surveying and cadestral mapping. The Sumerians are credited with building the earliest cities and making the first city maps. One of the earliest city-maps available in the world is of Hamri, the Sumerian city, "probably of Kassite period (1300 B.C.)"[2], which was found during the excavations at Nippur district, south of the Euphrates River (Figure 3.1). This map, prepared on a clay tablet, shows man-made features - city walls, gates, moats, houses and canals. The map is not only an ancient piece of art but also exhibits the existing levels of technology and the arrangement of functional areas within the city walls.

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[1]L. Bagrow and R.A. Skelton. History of Cartography. London: C.A. Watts & Co., Ltd., 1964, p. 31.

[2]Eckhard Ungar. "Ancient Babylonian Maps and Plans." Antiquity, Vol. IX, 1935, pp. 311-320.

# SUMERIAN CITY MAP

Circa—1300 B.C.

ON CLAY TABLET

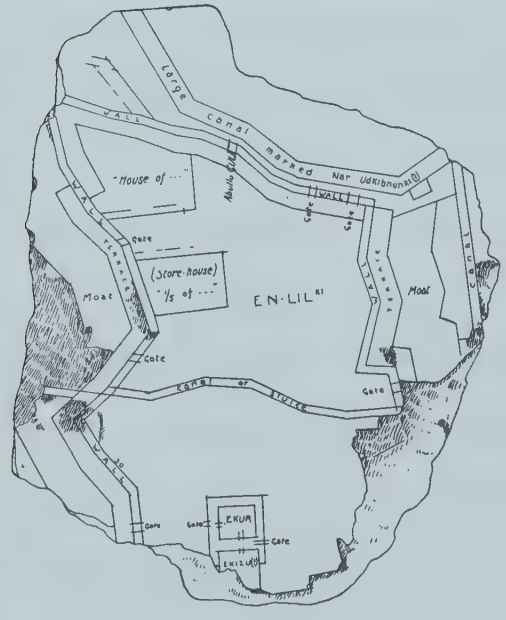


Figure 3.1

City walls performed two important functions: protection of people from invasions and division of activities between urban and rural areas. The planning of these cities was concerned only with the areas within the city walls and little progress in map making was experienced before the advent of the Renaissance.

Between the fifteenth and sixteenth centuries A.D., a few important events in cartography took place. Ptolomy's "Geographia" (geographical guide to map-making) was translated into Latin, inventions in printing and engraving methods were made, and global discoveries created greater demands for improved maps. One important result was Braun and Hoefnagal's great city atlas, "Civitates Orbis Terrarum"[1] which was produced in the seventeenth century A.D. This Dutch atlas, with its masterful detail, was a very significant event in urban mapping.

During the industrial revolution (late eighteenth and early nineteenth centuries A.D.) two events occurred simultaneously - rapid technological progress and the rapid growth of cities. This necessitated even greater emphasis on the planning of cities, which in turn required more sophisticated maps for analysis and presentation of relevant phenomena. Consequently, mapping of urban areas in most European and Western cities was practiced in the beginning of the present

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[1]Erwin Raisz. General Cartography. New York: McGraw Hill Book Company Inc., 1948, p. 28.

century. With the help of improved surveying and printing methods, a variety of urban maps can now be produced to serve the varied needs of their users.

At present, the graphic presentation of details on urban maps is in a process of significant improvement. The form of presenting planimetric details and relief features is taking on a new style, making urban maps more useful. This improvement reflects the technological advances made during the last fifty years in the areas of air-photography, surveying methods, and map production techniques. The role of air-photography is especially significant when considering the dynamic character of urban areas. With the help of air-photography, surveys of urban areas and construction of urban maps have become easier tasks. Air photographs are valuable and efficient aids but cannot be used in place of large scale urban maps, because they contain information in an unclassified manner. Urban maps present classified information required for a specific purpose, i.e., thematic information dominates other details. These differences are shown in Figures 3.2 and 3.3. The advantage of the urban land use map, especially in colour, is its presentation of qualitative and quantitative information in a simplified and hierarchical order. Functional areas are highlighted with less emphasis on less relevant information such as roads, railways, and other details. This selectivity enables users to comprehend spatial distributions and to distinguish functional areas

# EDMONTON

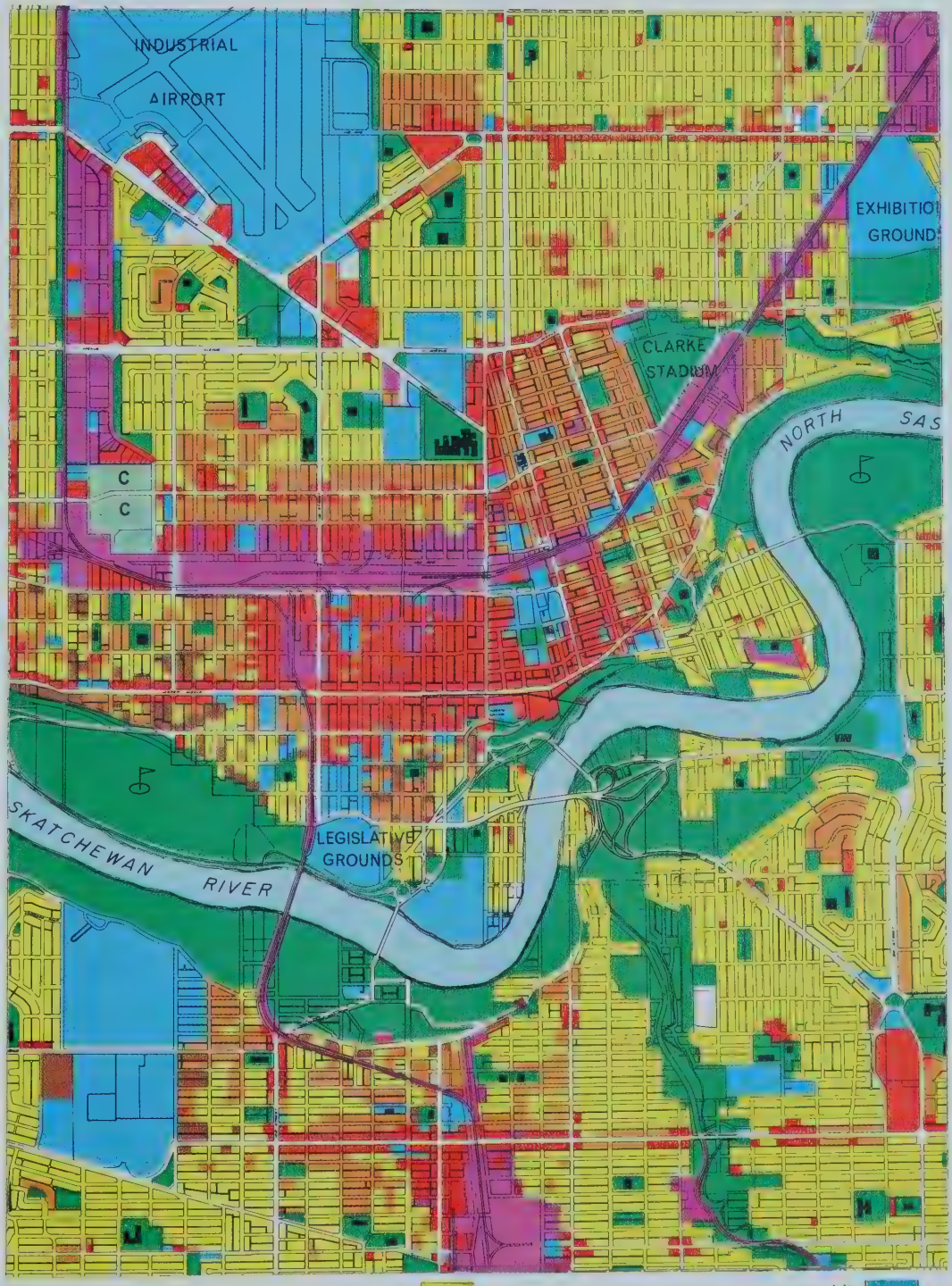
(CENTRAL PART OF THE CITY)

— UNCLASSIFIED INFORMATION

Figure 3.2

# LAND USE — 1972
# EDMONTON
(CENTRAL PART OF THE CITY)
0 0.5 1 km

## — CLASSIFIED INFORMATION




- Single Family and Duplex Dwelling
- Low Rise and Multiple Housing
- High Rise Residential
- Commercial
- Industrial
- Government, Institutional, Public & Semi-public
- School Buildings
- Parks, Playgrounds and Recreational
- Cemetery
- Vacant
- C

Figure 3.3

at a glance.

The development of the ortho-photo map, a combination of rectified aerial photographs enhanced by contours and other planimetric details, is a significant advance in urban mapping (Figure 3.4). The ortho-photo map is an ideal representation from the legal survey point of view as it simultaneously provides planimetric information and precise terrain details. The production of ortho-photo maps is of immense value, not only to administrators, but also to planning specialists and other urban researchers.

Photo-mapping is rapidly gaining in importance as a way of producing better maps with precise details and a graphic image of high quality. These improvements have been possible because of the effective use of digital computers, incremental plotters, and other devices used in map construction and reproduction. For example, high-speed digital computers have solved many problems associated with the collection, processing, and storing of data in the form of punch-cards, magnetic tapes and discs. The help of computers in mapping, in general, can be described simply as the introduction of a tool for storing, processing, and adapting data to the cartographic presentation relevant to the problem at hand. The output from the computer includes three forms: (a) a print-out using existing symbols on the output typewriter; (b) display of information on a television screen (Cathode Ray Tube); and (c) graphic display on a coordinatographic plotter commanded by computer-prepared

# ORTHO-PHOTO MAP

## EDMONTON

(CENTRAL PART OF THE CITY)

SCALE 1:1,000

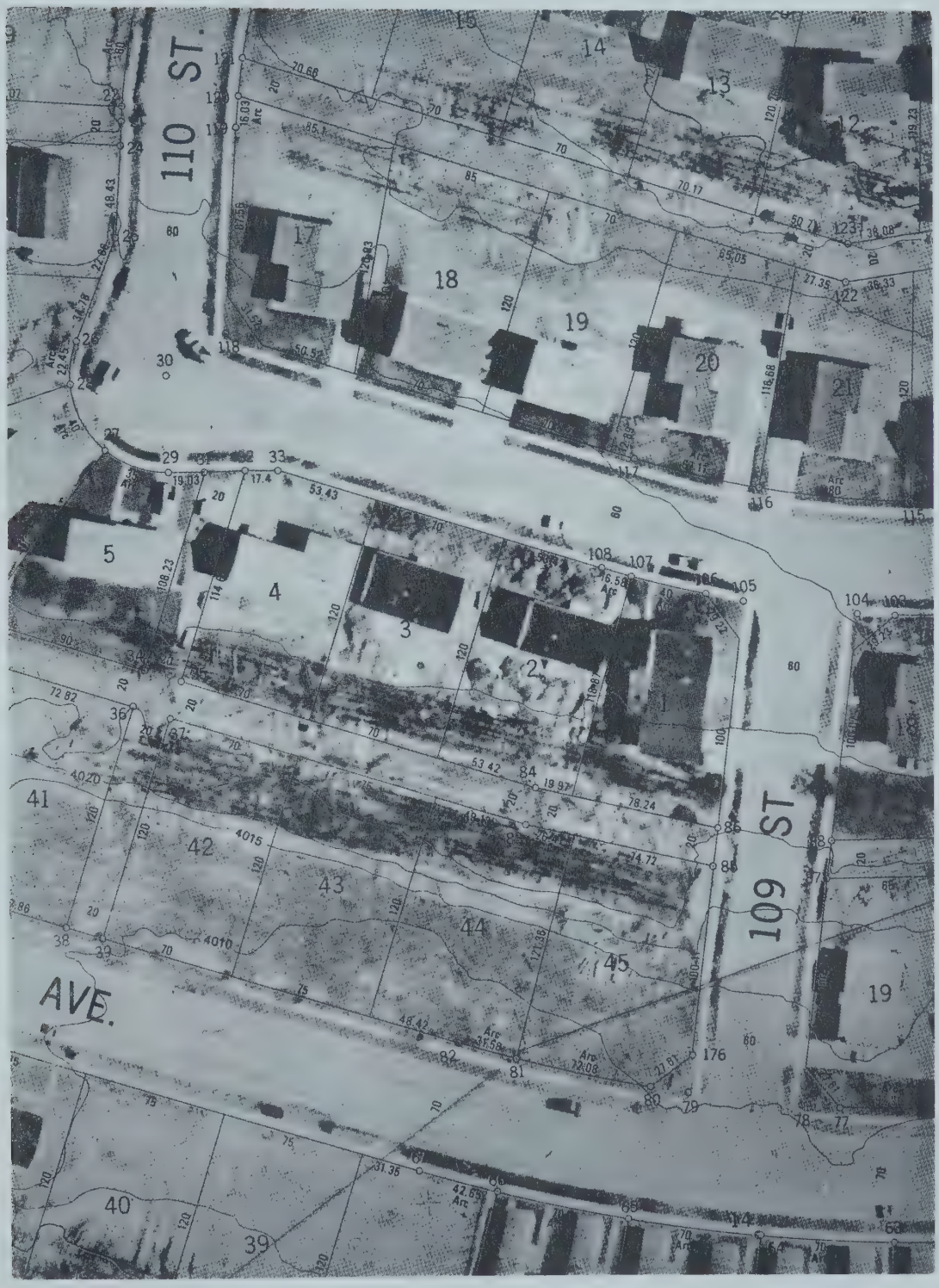



Figure 3.4

cards or tapes. All of these developments are not only changing the form of graphic images, but are also reducing the possibility of human error during the mapping process.

Computer-produced maps are another progressive step in the field of mapping (Figure 3.5). Of course they are not as aesthetically attractive as traditionally produced maps, but they allow a greater flexibility in the compilation and correction of data. Another advantage is that once a set of data is programmed, it can be presented in a much shorter time, compared with traditional methods.

Although great advances in map construction and reproduction techniques have been made, there is still a considerable gap between the evolution of new techniques and their practical application. This is due to the scarcity of resources, technological facilities and monetary investments in switching over from traditional techniques. Therefore, only in cities of the developed regions can new map production techniques be adopted. However, a continued search for improved computer techniques is likely to bring further improvements in mapping and satisfy the increasing demand for up-to-date and more useful urban maps.

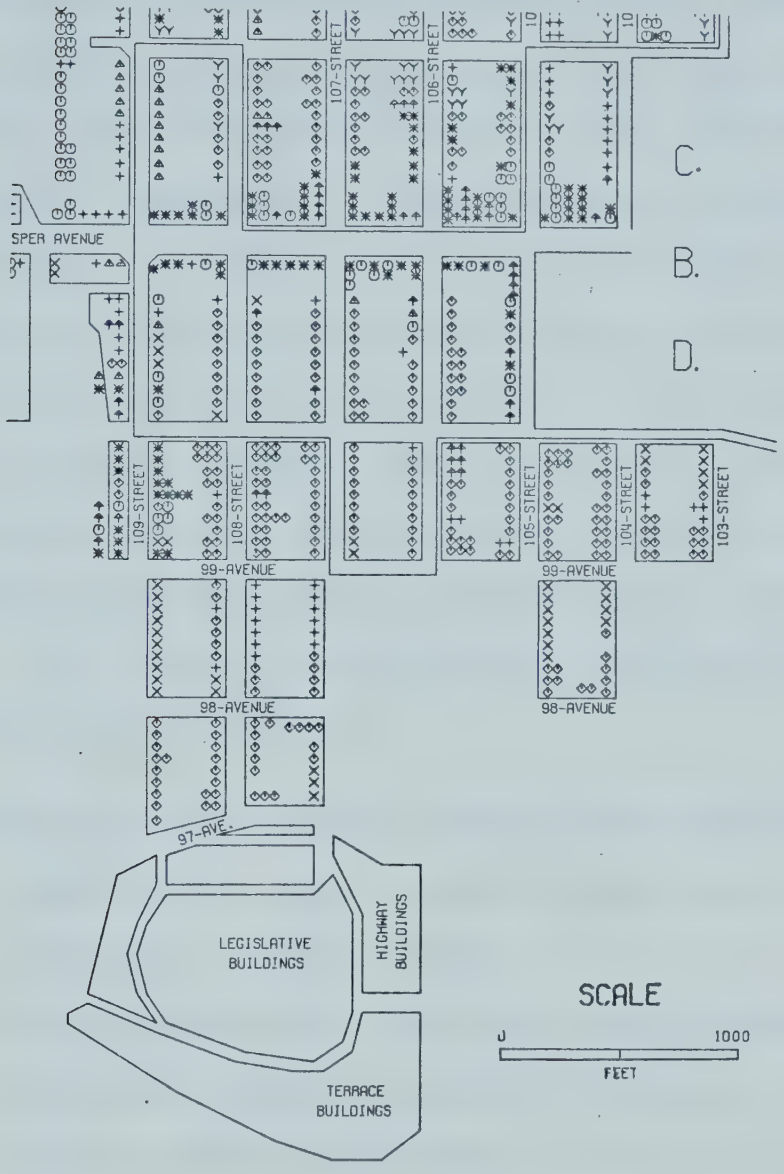
## B. Need for Urban Maps

Urban maps serve as an effective means of communicating and storing information. Citizens use urban maps as locational inventories, and authorities and specialists use

COMPUTER PRODUCED MAP

# LAND USE

## CENTRAL AREA OF EDMONTON




## LEGEND

| | |
|---|---|
| RETAIL | ✳ |
| SERVICE | ⏻ |
| OFFICE | ⏃ |
| WHOLESALE & WAREHOUSE | Y |
| INDUSTRIAL | ⏃ |
| PUBLIC & INSTITUTIONAL | X |
| RESIDENTIAL | ⏃ |
| VACANT & PARKING | + |

Figure 3.5

them as tools in the administration and planning of cities.

Urban maps portray selected information, and are normally prepared on large scales under themes to suit specific purposes. This is because of the varied needs of map users, the transitory nature of urban phenomena, and the dynamic character of urban entities. Populations of many cities, for example, are constantly changing. Most cities are composed of peoples having diverse ethnic origins, religious beliefs, cultural practices, habits, age groups, tastes, incomes, and social ranks. Besides this, there are various kinds of authorities, investigators and planners concerned with the administration and planning of cities. The various requirements of urban map users can be summarized as follows:

1. Citizens and tourists need maps for locating:
   - Residential areas - Highrise apartments, duplex and single family houses;
   - Shopping centres - size and type of shops;
   - Cultural centres - places of worship, community halls, auditoriums, etc.
   - Recreational areas - playgrounds, swimming pools, parks, coliseums;
   - Educational and medical facilities - schools, colleges, hospitals, medical dispensaries, medical offices;
   - Post and telegraph offices;

- Government departments, commercial service centres; and
- Roads, bus stops, railway stations, etc.

2. Civic authorities need maps in the administration of cities for:

- Visualizing the extent of various functional areas;
- Supplying urban services and utilities - water, gas, electricity, etc.;
- Keeping records of land registration, land use patterns;
- Considering the adequacy of service or market areas, welfare centres, and infrastructure facilities;
- Providing guidelines for the public on traffic circulation;
- Directing construction and maintenance activities;
- Preparing development plans; and
- Locating areas calling for urgent help, etc.

3. Urban researchers require maps for the study of:

- Historical aspects - evolution of cities, growth patterns, etc.;
- Physical aspects - extent of cities, functional areas, environmental conditions;
- Demographic aspects - population size, com-

position, growth, migration; and

- Economic aspects - location of economic activities, growth, factors of interaction, etc.

These are some of the information needs to which urban map makers are expected to cater. These needs are closely tied to the population and urban patterns of cities. The needs of citizens vary according to differences in literacy rates, social attitudes, transportation facilities, economic conditions, and the arrangement of functional activities within cities which can be judged from the number and type of maps available at each city. The needs of civic authorities and researchers vary according to variations in city size and function, and the influence of historical events on the existing urban conditions and planning problems. For example, in Hyderabad the old core areas present greater planning problems than the new areas, as is indicated in the city development plan.

The influence of these factors on the needs for urban maps can best be realized by considering the cases of Edmonton and Hyderabad. Although the Canadian Census does not record the literacy of the population, on the basis of the long history of compulsory education and the number of books and journals published in the city, it can reasonably be assumed that Edmonton has almost one hundred percent literacy. The city also has fixed locations for

functional activities and modern and efficient transportation facilities. The citizens enjoy a relatively high economic condition and efficient means of conveyance. Hyderabad, on the other hand, has only a 52.9 percent literate population (Census, 1971), poor economic conditions, narrow streets, less organized areas for functional activity and poor means of conveyance. These differences are reflected by the greater number of maps available to the citizens of Edmonton than to those of Hyderabad. Further, because of differences in urban patterns and planning policies, the needs of authorities and researchers vary to a large extent, and this is evident from the development plans of the two cities. Edmonton's plan is aimed more towards the development of new areas, whereas in Hyderabad, redevelopment of the existing unorganized areas is emphasized to a greater extent.

## C. Types of Urban Maps

The users of urban maps require accurate information to describe spatial information in the context of specific tasks. On the basis of content, function and scale, urban maps are classified under the following three types:

1. Base Maps,
2. General Purpose or Service Maps, and
3. Special Purpose or Project Maps.

1. Base Maps

The objective of the base map is to provide the reference framework over which selected information can be portrayed. Base maps are of primary importance and are required at the beginning of all research and planning activities. Normally, base maps carry selected, skeleton details pertinent to specific purposes, such as administrative boundaries, and a few other natural or man-made features (Figure 3.6). This detail allows the use of the same map for studies in such different fields as geography, sociology, and economics. But the amount of detail is not always fixed; it varies with the purpose of the study, the size of the area, and the scale of the map.

Since base maps are always required at the outset of a study program, they are compiled as derived maps. In most cases, in order to provide up-to-date planimetric or relief details, base maps are compiled from air photographs. In rare cases base maps are printed in several colours; otherwise they are produced in black and white, or in grey tones. Usually urban specialists prefer to have base maps printed a grey colour so that the essential information on the map is not obscured by the base map material. Base maps have to be reasonably accurate and need to be produced in a short period of time. Therefore, cartographers should aim for the desired accuracy and choose less costly and more efficient methods of production.

# BASE MAP

## EDMONTON

(NORTHERN PART OF THE CITY)

SCALE 1:5,000


Figure 3.6

HYPOTHETICAL

# DEVELOPMENT OF A BASE MAP

## URBAN LAND USE

SCALE 1:10,000


LEGEND

| | |
|---|---|
| 1 | RESIDENTIAL |
| 2 | COMMERCIAL |
| 3 | INDUSTRIAL |
| 4 | SCHOOL AND PARK |
| 5 | OPEN SPACES |

Figure 3.6 'A'

Essentially, base maps serve as intermediate maps from which final maps are constructed. For example, in Figure 3.6A, a hypothetical land use pattern has been constructed from the planimetric detail shown in Figure 3.6 (a base map). Similarly, the residences occupied by different ethnic, linguistic or religious groups can be shown.

As this discussion shows, the essence of an urban map is simplicity, a characteristic which is difficult to attain in the light of the complexity of the city. It is the speciality of urban maps to provide recent and meaningful information to the user. This speciality requires continuous monitoring and revision of urban data and of the techniques used to compile and produce urban maps.

## 2. General Purpose or Service Maps

These maps portray general information on a relatively small scale. The amount of information varies according to the theme, although general purpose maps are usually confined to individual sheets. Normally, the content of these maps includes major inter-city highways, railroads, city routes, parks, playgrounds and a few important locations (Figure 3.7). Common themes for general purpose maps include the City Guide Map, the Bus Route Map, and the Sight-Seeing Map.

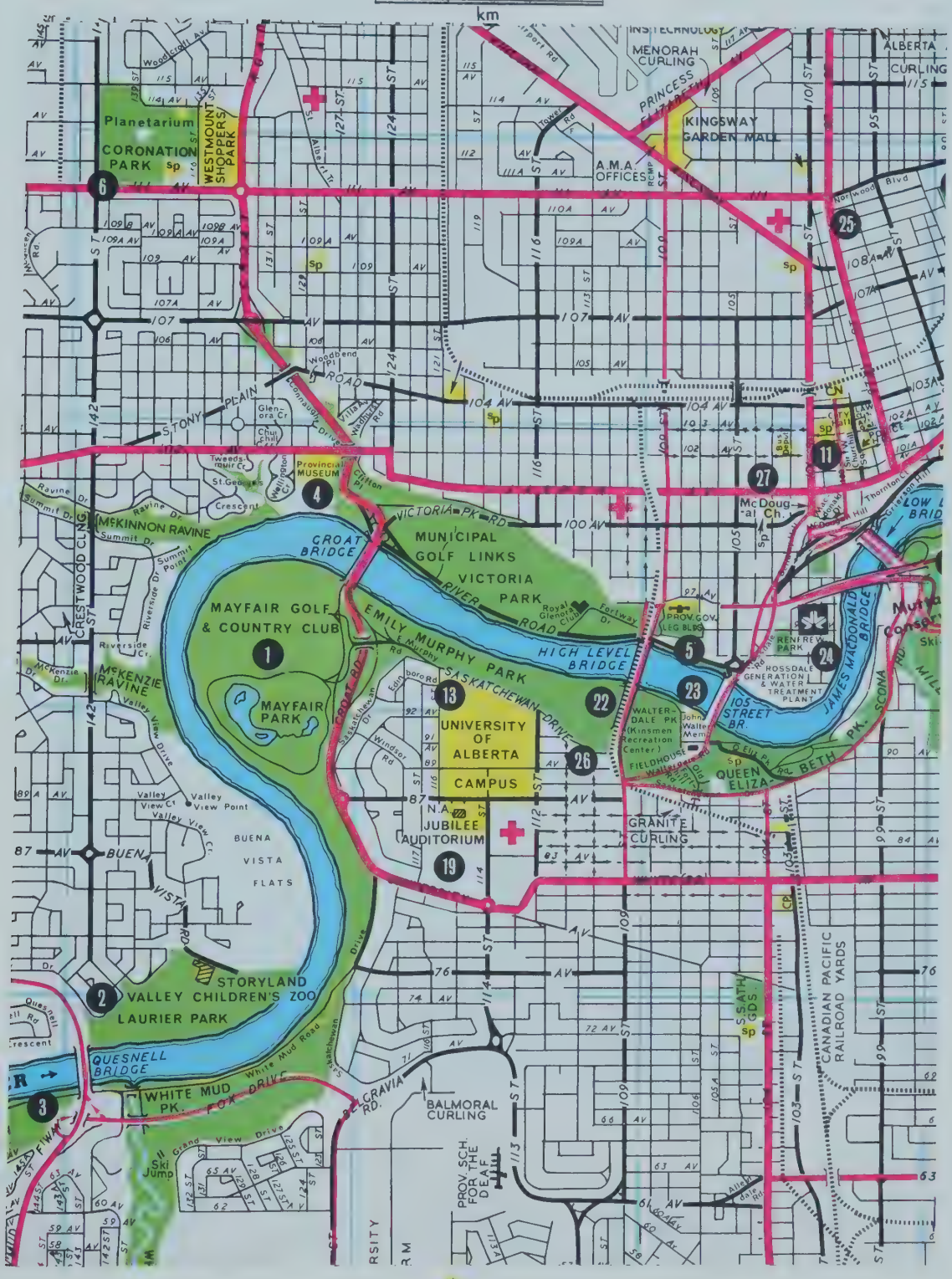
# GENERAL PURPOSE MAP

## EDMONTON

(CENTRAL PART OF THE CITY)

0 0.5 1 1.5

km




Places of Interest
Swimming Pools
Through Roadways
Secondary Roadways
Parkland
Hospitals
Other Roadways
Railroad

Figure 3.7

### 3. Special Purpose or Project Maps

Unlike general purpose maps, special purpose maps portray selective information required for specific purposes. For example, the map seen in Figure 3.8 shows the surface, underground, and overhead arrangement of utilities in a particular area, with other planimetric details. This is the only information the map conveys and is of importance mainly to users concerned with utilities. They are produced on individual sheets as well as in series, usually on large scales. Special purpose maps are of great value, particularly to the specialists and authorities who use them in administrative work, research studies, and planning projects.

# SPECIAL PURPOSE MAP

## EDMONTON

(CENTRAL PART OF THE CITY)

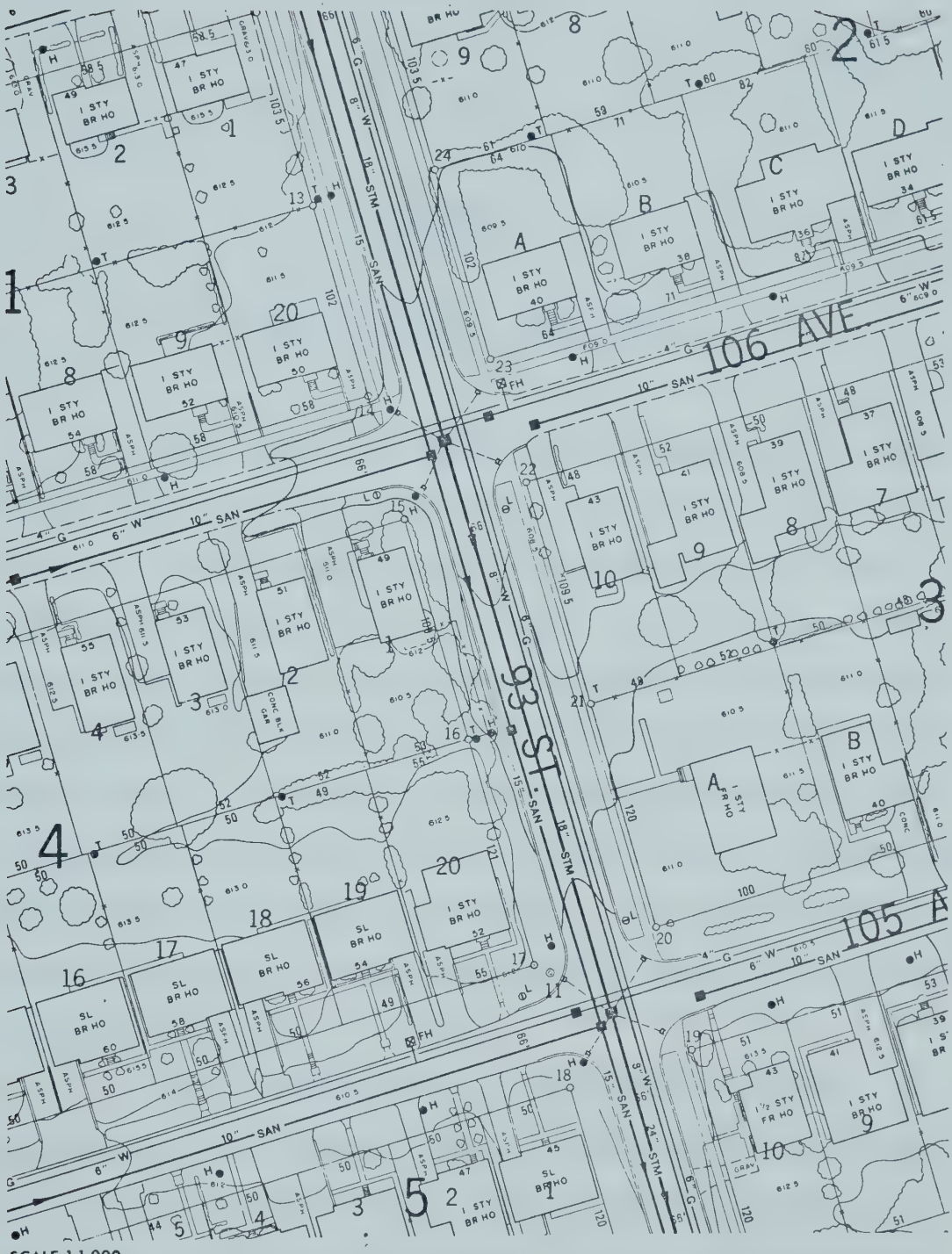



Figure 3.8

# CHAPTER IV

## CONSTRUCTION OF URBAN MAPS

Urban maps are constructed to serve as a means of communication and as an important tool for different groups of people. Information on maps is presented by means of graphic symbols spatially arranged in two or three dimensions. The contents of maps representing urban phenomena are compiled either from original surveys or derived from existing maps. Normally, a combination of these sources is considered necessary to save time, observe economy, and provide the most recent information. The entire mapping process consists of three main stages, shown diagramatically in Figure 4.1.

In the first stage, measurements of urban phenomena are conducted through various types of surveys; for instance, field investigations, air photography, or from published secondary sources. In the second stage, collected data are processed and then classified into qualitative and quantitative types, and the quantitative data are arranged in nominal, ordinal, interval and ratio

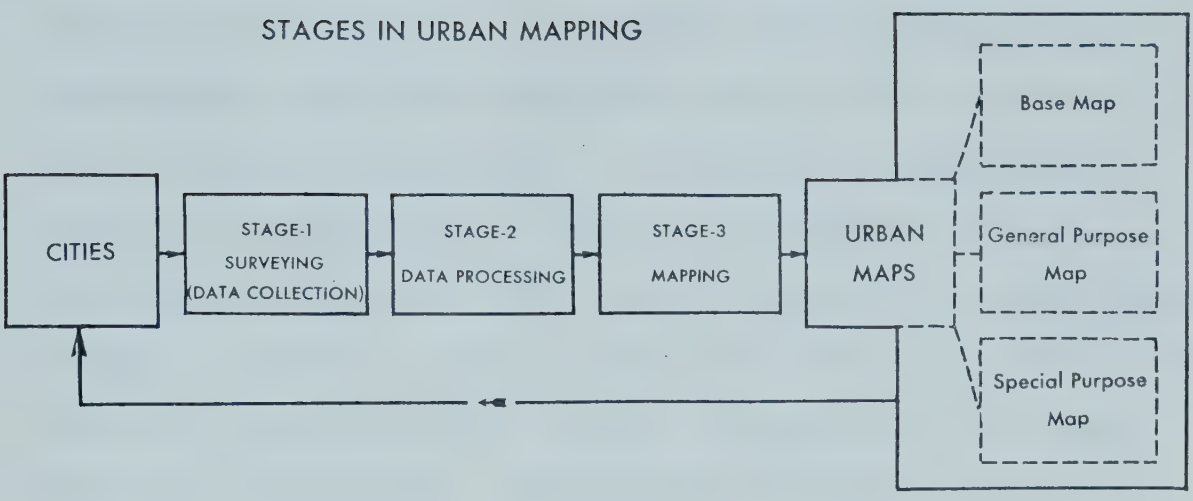



Figure 4.1

form. In the third stage, the data are symbolized and urban maps are produced. Finally, all three types of maps - base, general purpose, and special purpose - are made available to their intended users.

In the construction of urban maps, the cartographer, if working alone, needs to have not only a profound knowledge of the map production processes but should also have a good understanding of urban entities and their characteristics. This is very important because cities are comprised of various elements which have different characteristics. For example, some cities are fast in changing their morphology and others change at a slower rate. Therefore, many of the forecasting and policy decisions on various

urban problems are made on the basis of specific information supplied through urban maps as auxiliary documents. In this way, the cartographer has a greater responsibility to present information in a suitable form by taking into consideration the many characteristics of urban entities. This is especially true for the distribution and growth patterns of populations, extent of functional activities, and land use patterns, which need an adequate representation on maps in order to make planning decisions more efficacious. Greenhood[1] drew attention to the representation of latent features when he said: "There are often many truths in a place or an area right before our eyes, and yet we're not aware of those truths (or features, or facts) until a depiction or a symbol or even a diagram shows them to us." Certainly, in representing reality, the cartographer is not completely free to choose detail at his own discretion; nevertheless, his familiarity with urban features can add more meaning to urban maps. Of course, if the cartographer is not familiar with urban matters, he has to work in a team with an urban specialist.

The effectiveness of maps is linked with the selection of data, choice of scales, consideration of projections and symbolization of data. These are the basic elements which affect the content of a map and constitute

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[1]David Greenhood. Mapping. Chicago: The University of Chicago Press, 1951, p. 10.

the cartographic design. Due to their great importance in the construction of maps, these elements are discussed below individually.

A. Collection and Classification of Data

For constructing urban maps and portraying natural or man-made features and populations, data are collected in the form of numerical values (i.e., statistics) or imagery. The main sources of data are:

1. Published and unpublished records which contain statistical tables and maps. Available in government, commercial, private, research or organizationally produced books, reports and atlases.
2. Remote sensing in the form either of aerial photographs (oblique and vertical) or scanned imagery from space, providing visible details of city areas.
3. Field surveys, for the detailed measurements of planimetric details of city areas, conducted by survey parties using plane-tables and other surveying instruments.
4. Data banks, which supply geographic information in coordinate form through paper or magnetic tapes, discs, or punch cards.
5. Personal inquiries, through observation, photographs, telephone calls, interviews and written question-

naires.

These are the possible data sources but not all of them are available in every city of the world. For example, to use aerial photographs as data sources, a city must have well-built ground control monuments for aerial surveys and other technological facilities. Presently, Edmonton has these facilities, but although Hyderabad has the technological facilities, it still must build ground control monuments to facilitate the air survey methods.

The collection of data through remote sensing is a very valuable technique. This method usually allows many types of surface data to be collected and processed within a few hours. This data source is especially valuable with respect to hazards such as earthquakes, floods, fires, air pollution, etc. However, even with regard to city development projects, data about the progress of work can be collected efficiently by remote sensing. Field surveys and personal inquiries normally involve a considerable amount of time, but in certain geographical, demographical and economical studies, they are the only sources from which the desired data can be collected. For general types of data, published and unpublished records are readily available sources which are common to most cities of the world. The cartographer must always consider the authenticity of each source and refer to those which provide the most up-to-date information.

It is also desirable to check the degree of conformity of the data with the actual situation to aid in providing correct and precise information on urban maps.

Data collected from various sources are grouped into two types - qualitative and quantitative. Both types of data can be processed either manually or with the aid of computers, and classified into various categories with reference to general subtypes. Normally, all quantitative data are classified and arranged for mapping purposes in nominal, ordinal, interval, or ratio form. The storage of data is also a vital consideration. Currently the computer is considered the most efficient tool for data storage. Therefore, in most cities, the practice is to store digitized data in machine-usable form, i.e., punch cards, paper and magnetic tapes or magnetic discs.

Usually data collected for a specific purpose involves great quantities which cannot be totally represented on maps due to scale limitations. Therefore, generalization of data becomes necessary, which helps to maintain the visual balance of the graphic image, and does not allow the information to be over-crowded on the map. The measure of generalization is closely associated with the map scale, which is a dominant element in the construction of maps.

## B. Selection of Map Scale

The scale is the ratio of distances on a map to corresponding distances on the ground. Throughout the world these distances are measured in different units of measurement, with centimeters, inches, etc. on a map corresponding to kilometers, miles, etc. on the ground. Normally, scale on maps is expressed in one of the three conventional forms: descriptive, representative fraction, and graphical. Due to the vast differences between the size of cities and the size of map construction materials, all types of urban phenomena cannot be represented on the same scale. Therefore, urban maps are constructed at varied scales according to their specific purposes.

The selection of scale determines the amount of information, form of projection, and the size of symbols which can be used on the map. Concerning the importance of scale in the construction of maps, Monkhouse[1] wrote, "The amount of detail which can be included is clearly a function of the scale, in that a large-scale map will show a smaller area in greater detail than a small-scale map." Thus, the scale functions as one of the most important map elements affecting the details of the phenomenon to be shown. In mapping, large-scale and small-scale are relative terms

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[1] F.J. Monkhouse and H.R. Wilkinson. Maps and Diagrams. London: Methuen & Co. Ltd., 1963, p. 16.

which always have reference to the scale of a map and the area represented on it. In comparison to the scale and area shown on the topographic maps, urban maps are generally considered as large scale maps. They represent comparatively small areas and show more detail than, for instance, a topographic map. However, urban maps are constructed on a wide range of scales, depending on the size of the city, purpose of the map, and the amount of detail required. For cities like Edmonton and Hyderabad, having an area of around 200 $km^2$, general purpose maps are normally constructed at a 1:50,000 scale. The special purpose or project maps are at 1:1000, 1:500 or larger, depending on the nature of the area, the work, or the type of study. The scale of base maps varies considerably and ranges between 1:5,000 and 1:500 for inter- and intra-urban level studies. The inter-urban level studies are concerned with the migration of people and movement of heavy vehicles, and do not require much map detail, whereas intra-urban studies, concerned with such variables as distribution and composition of populations, land use patterns or traffic flow, need more detail.

All three types of maps - base maps, general purpose maps and special purpose maps - have variable scales. That is, the scale and amount of information varies according to necessity from time to time. Often the cartographer encounters the problem of selecting a suitable scale which will represent the required detail for a

specific purpose. The selection of scale affects not only the amount of detail and the symbols and layout of a map, but also the reproduction process, and, therefore, the time and financial involvement. The scale of a map should not be such as to hide the information, reduce legibility or detract from the objective.

Because of these factors, the selection of scale represents an important step in the construction of urban maps. A map scale should always be selected by considering the size of a city or an area and the amount of detail required. The other considerations include financial capability, technological facilities, and the time allowed for construction of the map.

## C. Selection of Map Projection

Suitable representation of the earth and its phenomena has long been the endeavour of cartographers. The globe is a relatively true representation of the earth which shows generalized surface features and lines of latitude and longitude at reduced scale. Its use is very limited, however, mainly to the location of continents, major regions, countries, and a few important cities. The globe is least helpful for practical purposes, particularly to compare regions and cities, to measure distances, and to analyze areas. The need for map projection arises from the very fact that an ordinary globe is rendered useless

for detailed studies of the earth and its varied phenomena. Projections are devices for representing the spherical shape of the earth or part of it on a plane surface.

On the globe, lines of latitude and longitude are circles and areas are of spherical shape. When they are transferred to a plane surface, the lines of latitude and longitude become intersecting, curved or straight lines, and the shapes are distorted. The amount of distortion varies from one projection to another. At present there is no single projection which preserves correct area, shape distance and direction. This is due to the transformation of the three-dimensional earth surface into a plane surface or two-dimensional form. However, the distortion is relatively small in the representation of smaller areas as compared to larger areas of the world. On this subject of distortion, Raisz[1] wrote, "As long as the area is small, the problem is not great. Even in a distance of 100 miles the scale error of many projections is less than one in 10,000, which is negligible for practical purposes. The larger the area to be mapped, the more serious is the problem, and it is greatest on world maps."

The selection of a projection is made by considering the size and shape of the area to be portrayed, the purpose of the map, and its intended users. This is

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[1]Erwin Raisz. Principles of Cartography. New York: McGraw Hill Book Co. Inc., 1962, p. 166.

essential because properties of each map projection vary. Any one quality, i.e., correct area, shape, distance or direction may be achieved by a certain map projection at the cost of others. For example, areas are represented equally in 'Homolographic Projections', shapes are correct in 'Orthomorphic Projections', and directions are true in 'Azimuthal Projections'. Normally, by considering the purpose, the required qualities, and the areas to be represented, a projection is selected from existing models. The choice of projection is very important, depending on the characteristics of the information.

Urban maps represent small areas, compared to the topographic maps portraying major regions or countries of the world. Technically, urban maps are considered as conformal maps on which small areas such as cities have the same shape as on the globe. For example, Edmonton and Hyderabad each have an area of approximately 200 square kilometers which is 1/2,500,000 of the world's total surface area. Given this great difference in area, the spherical shape of the earth's surface is not an important matter in the construction of urban maps. Moreover, throughout the world urban maps are normally constructed at fairly large scales, ranging from 1:100 to 1:25,000. Therefore, in spite of being an important map element, the selection of projection is not as significant as for small scale maps.

D. Symbolization of Data

Maps are constructed to communicate information in some organized fashion. Keates[1] defined a map and its content as follows: "A map is a graphic image, and information is presented by means of graphic symbols which are perceived by the user." Hence, symbolization is a process in which, through a suitable choice of symbols, the data is converted into graphical form. Symbolization of data is not a new phenomenon; rather it is an old practice which has been improving with the progress of cartography. The objective of symbolization is to present data in the most effective fashion within the limited space available on a map.

The symbols on a map consist of discrete points, lines, areas, and alphanumerical symbols. They are used to represent both qualitative and quantitative types of data. The point symbols are most often used for showing the location of places or the distribution, size and growth of populations. Line symbols are commonly used for portraying the spatial extent of phenomena such as rivers, roads, boundaries, and movement of people or vehicles. Area symbols are generally used to display phenomena such as patterns, densities of populations, and climatic conditions. The size, form and colour of all three types of

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[1] J.S. Keates. Cartographic Design and Production. New York: John Wiley & Sons, 1973, p. 11.

symbols may vary according to the volume of data, scale, and purpose of a map.

The symbolization of data is an important process in the construction of urban maps. The cartographer's choice of symbols carries great value which can either enhance or mar the contents of a map. A suitable selection of symbols ensures both clarity of information and visual balance in the map. An improper selection of symbols not only overburdens a map but makes other efforts futile. The rule of symbolization according to Raisz[1] is that "A symbol should be simple, yet distinctive, small and easy to draw. A good symbol can be recognized without a legend." In fact, symbols can be more self-explanatory when a high degree of standardization is achieved at the international level. Unfortunately, progress in this regard is slow and cartographers still use different symbols for the same type of phenomena in most cities of the world. For example, in Edmonton city maps, the railroad is portrayed by discontinuous lines, and in Hyderabad by continuous lines, as is shown in Figure 4.2.

The simplicity and distinctiveness of symbols are closely linked to the volume of data, and the scale and the symbolization of data within the limited space of a map often necessitates generalization. This generalization

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[1]Erwin Raisz. Principles of Cartography. New York: McGraw Hill Book Co. Inc., 1962, p. 35.

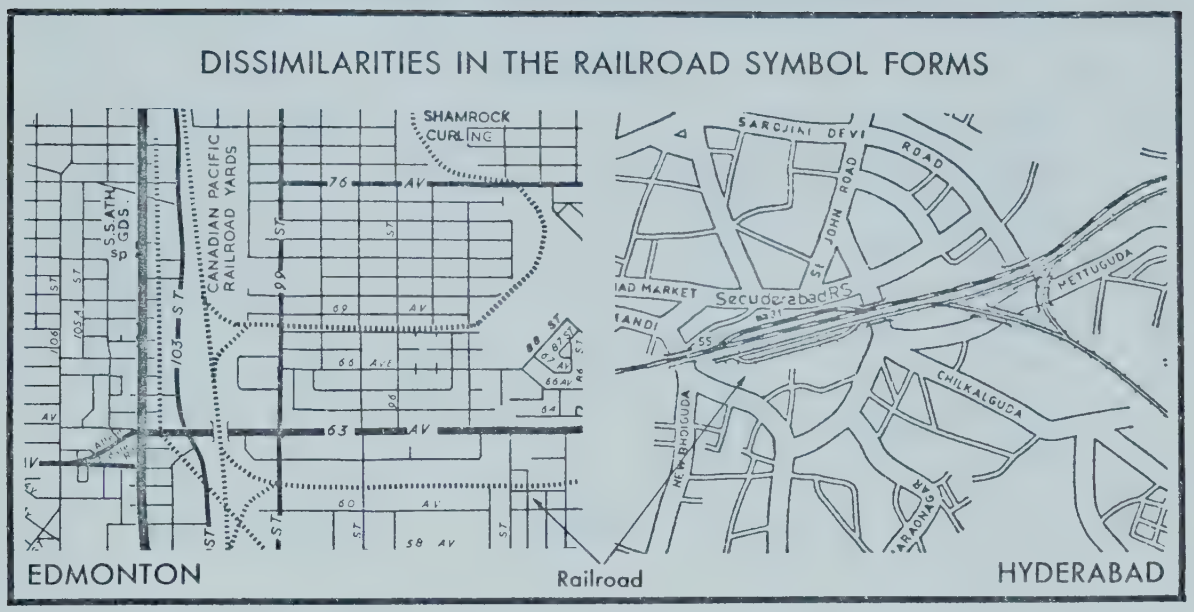


Figure 4.2

usually causes certain amounts of data to be either omitted or reclassified and represented by fewer symbols. For example, in a city map, roads can be shown either with double or single lines, and important buildings according to their shape or by point symbols. The most important factor is that during generalization the specific character of the data must be retained. In generalization there are certain limitations which can never be ignored; for example, a meandering river cannot be generalized into a straight line. A few such other examples are shown in Figure 4.3.

Symbolization of data must always be effective in creating a better graphic image and in achieving the desired objective of the map. Each of the four types of symbols can

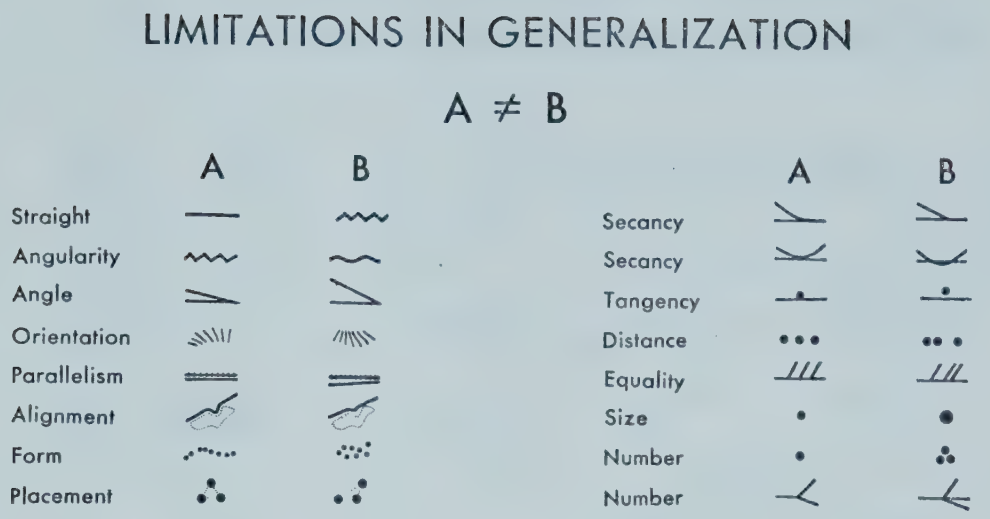


Figure 4.3

be used in a number of ways, but a careful selection of the best symbols, by considering the volume and types of data, can produce better and more effective maps. On some maps geometrical or pictorial symbols can be used to portray special types of information. A suitable application of both geometrical and pictorial symbols is shown in Figure 4.4.

## E. Cartographic Design

Cartographic design is concerned with the presentation of information in an organized form. Many factors are integrated in the design of a map, which influences both map construction and reproduction processes. Realizing the

# A SUITABLE APPLICATION OF SYMBOLS BY CONSIDERING CHARACTERISTIC TYPES OF DATA

| CONTENT SCALING LEVEL | DEFINING RELATIONS | FORM OF CARTOGRAPHIC SYMBOL | | |
|---|---|---|---|---|
| | | POINT | LINE | AREA |
| NOMINAL | (1) Equivalence | Wholesale & Retail Establishments | Highway Connectivity | Land Ownership |
| ORDINAL | (1) Equivalence<br>(2) Greater than | small medium large<br>Population Centers | Roads by Degree of Improvement | Land Value |
| INTERVAL | (1) Equivalence<br>(2) Greater than<br>(3) Known ratio of any two intervals | Spot Elevations | Avenue / Street | Date of Industrial Establishment |
| RATIO | (1) Equivalence<br>(2) Greater than<br>(3) Known ratio of any two intervals<br>(4) Known ratio of any two scale values | Area Proportional to Population | Population Density Isopleths | Darkness proportional to Population Density |

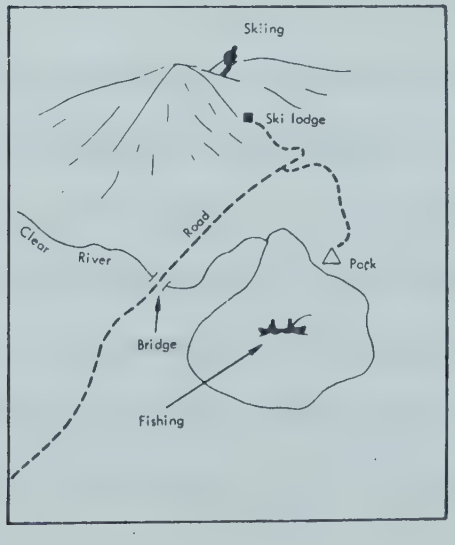


Figure 4.4

importance of map design, Robinson[1] wrote, "Of all the aspects of cartography, map design is perhaps the most complex ... if the map has not been properly designed it will be a cartographic failure."

In designing urban maps and presenting information by means of graphic symbols, the cartographer must consider a number of factors concerned with map design. These factors are: volume of data, scale of map, method of presentation, technical facilities, and user's requirements. The user's level of understanding and the circumstances of use, as well as time and cost, must also be considered. Hence, map design is an integrated effort which is a critical part of the cartographer's work. After having initially looked into all these factors, the cartographer considers in detail the complexity of data, selection of symbols and choice of colours. He also decides upon the spatial arrangement of map elements such as the map itself and its marginal information.

The major concern in the design of maps is that the information be presented with specific details and in hierarchical order. Therefore, a cartographer establishes hierarchies in the presentation of information and chooses accordingly the size and shape of symbols and use of colours. The information most relevant to the theme of the map is presented dominantly, and other less important

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[1] A.H. Robinson. Elements of Cartography. New York: John Wiley & Sons, 1967, p. 222.

information is subordinated. For example, the 'City Transit Map' of Edmonton or Hyderabad will dominantly show all major roads, bus routes, names, numbers and location of bus stops, and frequency of bus service. Additional information such as locality names, important buildings, parks, rivers, etc., will be shown as subordinated or secondary information. If the information is spatially organized and presented with clarity and legibility, the design is then considered good and effective.

The function of design is to communicate information effectively. In designing maps it is very important to have visual balance in the image of a map, regardless of whether a map is a monochrome or chromatic product. The information of a map should neither be over-burdened, nor should it escape the user's attention. In most cases the design depends upon the degree of accuracy required and on the amount of detail necessary for a specific purpose. The clarity of information and its visual effectiveness in communicating the information to the map user are always indicative of good cartographic design.

# CHAPTER V

## CARTOGRAPHIC METHODS AND PRODUCTION OF MAPS

### A. Cartographic Methods

Maps function as a means of communication by presenting data in the form of graphic symbols. The design of maps involves the choosing of an appropriate method of symbolization from a number of alternatives. Selection of an appropriate cartographic method is particularly important in urban mapping because of the crucial role urban maps play as auxiliary documents or as specialized research and administrative tools. Considering the importance of methods, Imhof[1] observed: "The impression of density from any population map depends considerably on graphical forms ... the results of methodological faults have led to extreme misrepresentation."

There are eight cartographic methods available for translating statistical data into graphic form. These methods are: (1) Cartodiagram, (2) Choropleth or Cartogram,

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[1]Edward Imhof. "The Tasks and Methods of Thematic Cartography." International Yearbook of Cartography, Vol. 3, 1963, p. 21.

(3) Dasymetric, (4) Dot, (5) Isoline or Isopleth, (6) Areal or Extent, (7) Symbols, and (8) Chorochromatic. On the basis of their normal applications to different types of data, the methods are divided into quantitative and qualitative groups. The first five methods are considered as quantitative methods and the remaining as qualitative methods. All eight methods are used in urban mapping since urban maps require the presentation of both quantitative and qualitative data.

## B. Application of the Methods

### 1. Graphs or Diagrams and Cartodiagrams

In cartography, the words "graph" and "diagram" are used interchangeably in association with numerous adjectives; for example, line, bar, star, spoke, pie, triangle and climatographs. Most of these graphs are very simple and can be used for representing different types of data whether in absolute values, percentages, or degrees. Raisz[1], commenting on the use of diagrams, observed that "Modern science could hardly have been developed and certainly it could not have been transmitted without the use of diagrams." Diagrams are quite indispensible as they are frequently used to present complicated relationships in an easily understandable form.

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[1]Erwin Raisz. General Cartography. New York: McGraw Hill Book Co. Inc., 1948, p. 235.

Line graphs are generally used to show population growth patterns, land use values, etc. They are also used for comparing similar types of phenomena in two different areas or cities, as seen in Figure 5.1A. Such a comparison shows at a glance the significant differences in land use areas of Edmonton and Hyderabad. Particularly, it is interesting to see that Hyderabad, with a population about three times larger than Edmonton, has proportionately smaller areas for various functional uses. In most cases, these line graphs are very simple to draw and yet show the phenomena most effectively. Similarly, horizontal and vertical bar graphs are used for depicting migration trends, variation in populations, and production of commodities. The polygraph and star graphs are commonly used to portray spatial developments or climatic conditions.

Pyramid graphs are specifically used to show the structure of a city's population; i.e., age and sex differentials. Circles, triangles, and cubes are used to depict the composition as well as ratio of ethnic, religious and linguistic groups within a population. Sometimes spheres are also used to show the location and size of cities or small urban centres in a province, region, or country.

In most cases, graphs are drawn separately; that is, not within the administrative boundaries. But when they are drawn on a map at an appropriate location within administrative boundaries, the map and graphs together become a cartodiagram, as seen in Figure 5.1B. The special feature

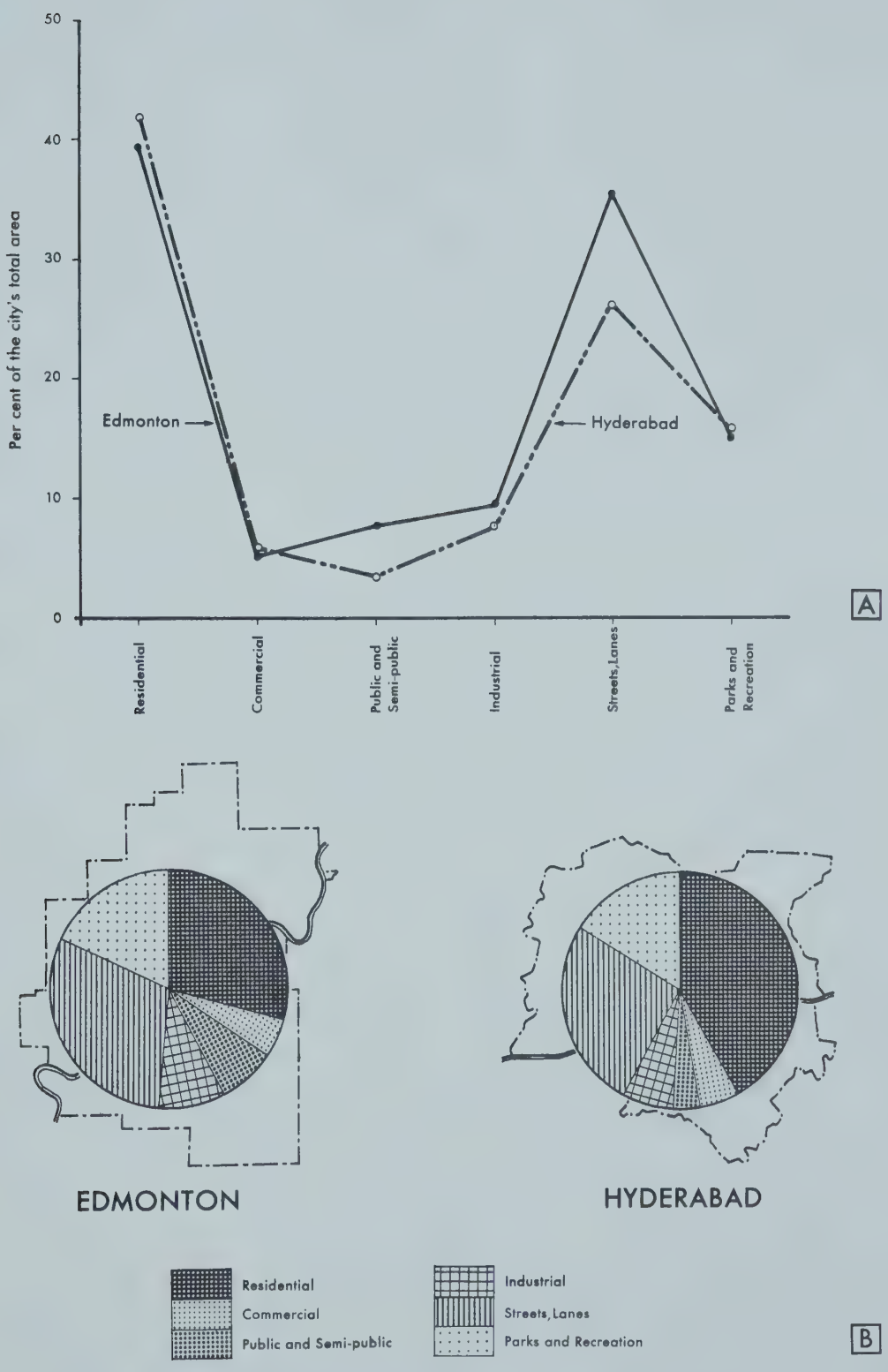



Figure 5.1 'A' and 'B'

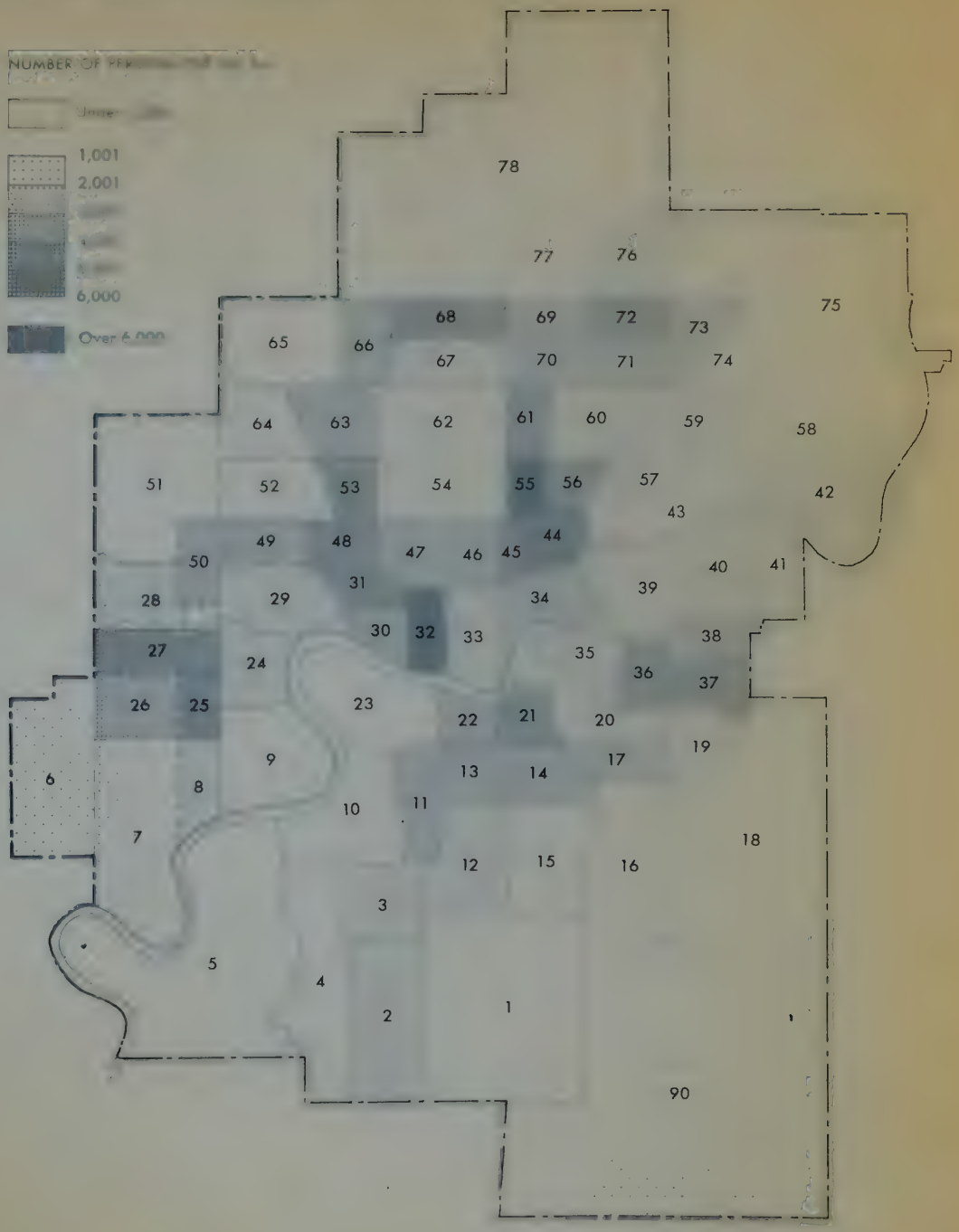
of a cartodiagram is that it provides a better visual image which helps in the rapid comprehension of a phenomenon with regard to its locational aspect.

2. Choropleth or Cartogram Method

Normally, cities are divided into census tracts or wards to facilitate the collection and presentation of statistical data for sub-areas of the city. On urban maps such statistical data are represented in terms of related values; for example, density of population per square kilometer or percentage change in populations, areas and their composition patterns.

The choropleth method is used for portraying such related values because it is simple and usually does not involve much computation. In this method, the data are grouped into suitable class intervals and each class is then assigned a graded value (mono or multi-colour) in a sequential order. Later, each administrative unit is completely symbolized by considering both individual as well as class interval values. The density of population maps in Figure 5.2A and 5.2B have been prepared using this method. A comparison of these two maps indicates that the high density areas are concentrated around the CBD in Edmonton and to the south as well as the extreme north of the river in Hyderabad. It is noteworthy that, despite considerable differences (1:10) between the density ratios of Edmonton and Hyderabad a useful representation of data

## CENSUS TRACT NUMBERS



# CENSUS TRACT NUMBERS

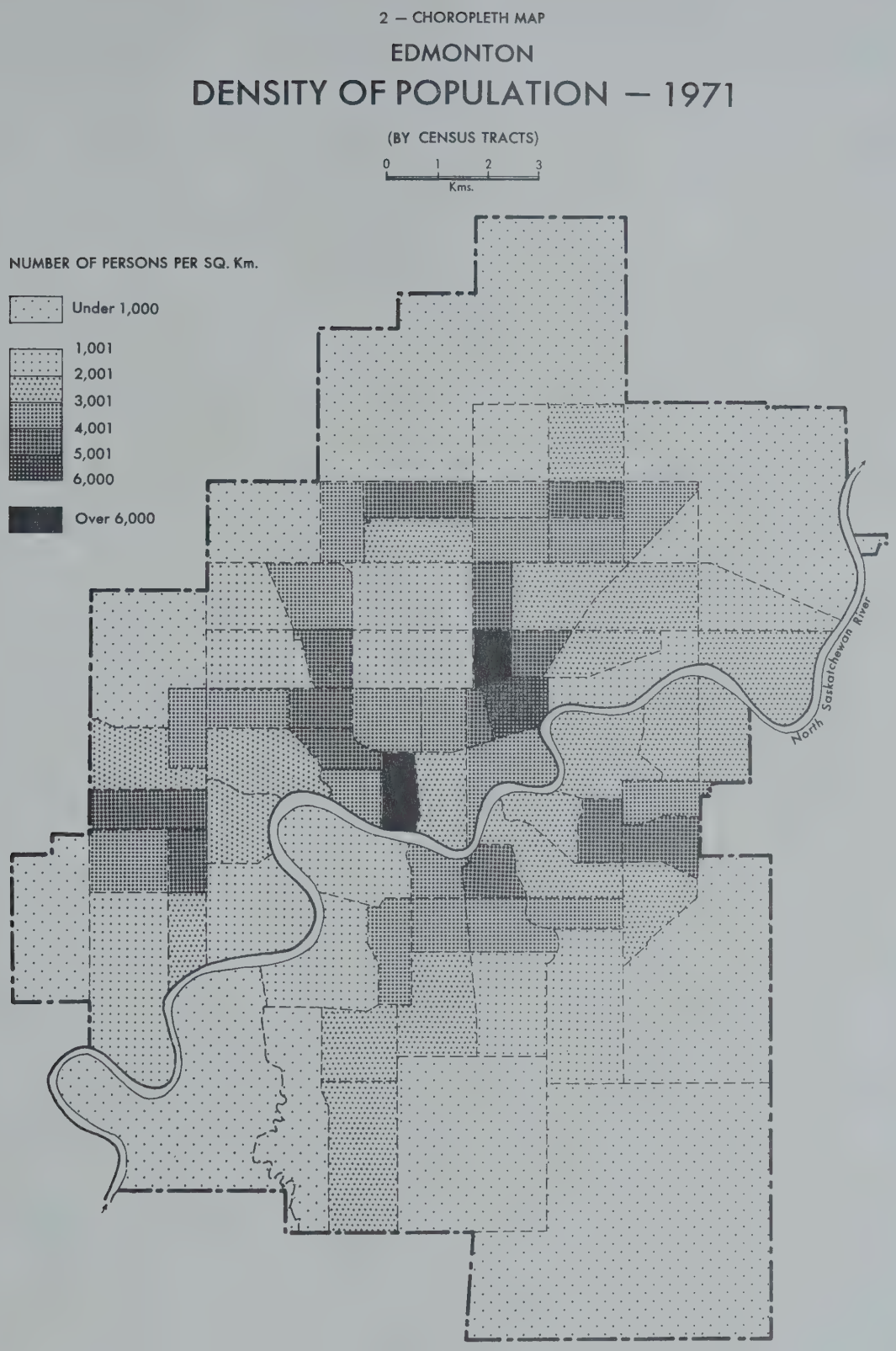

2 — CHOROPLETH MAP
EDMONTON
DENSITY OF POPULATION — 1971
(BY CENSUS TRACTS)
0 1 2 3
Kms.
NUMBER OF PERSONS PER SQ. Km.
Under 1,000
1,001
2,001
3,001
4,001
5,001
6,000
Over 6,000
North Saskatchewan River

Figure 5.2'A'

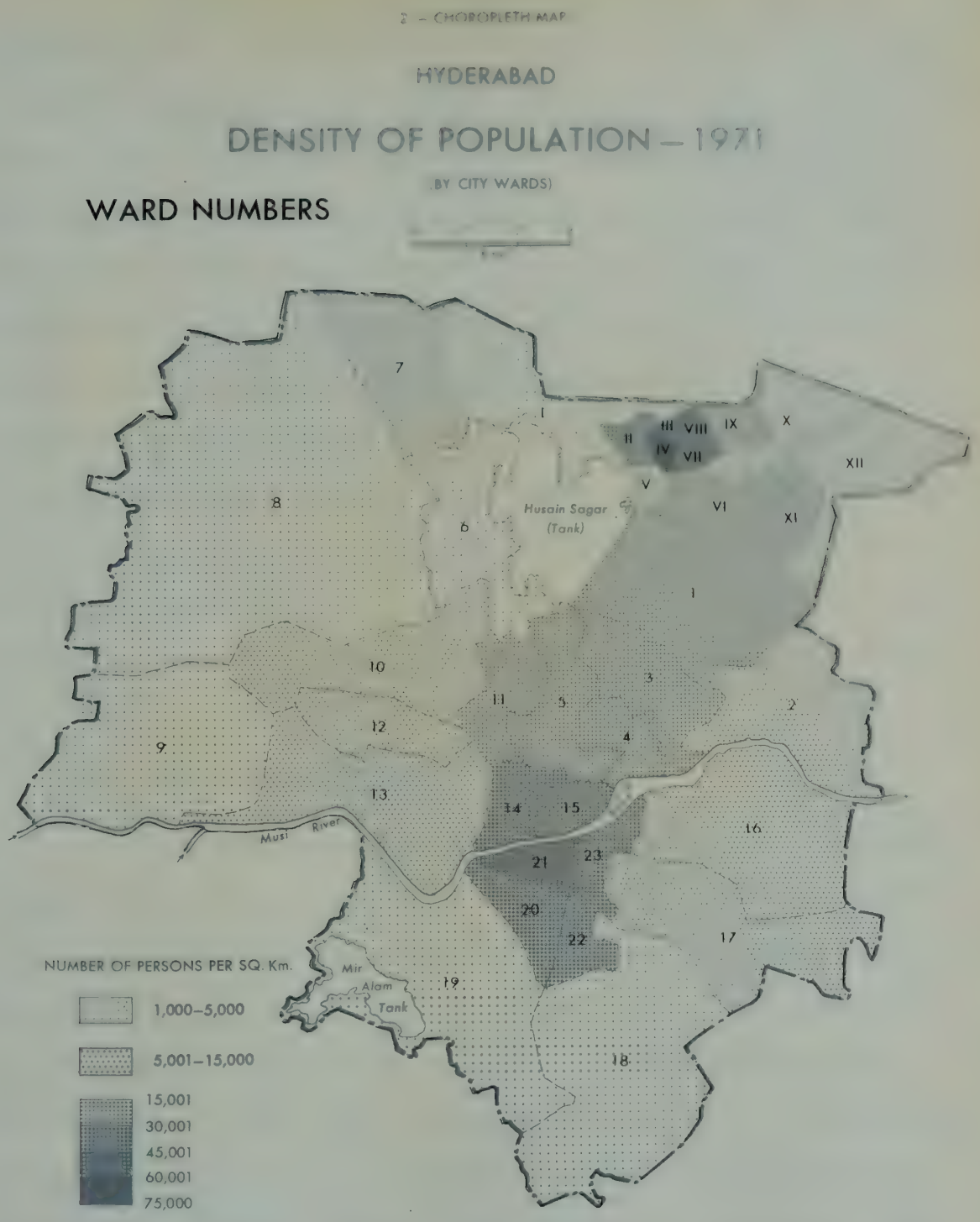

2 – CHOROPLETH MAP
HYDERABAD
DENSITY OF POPULATION – 1971
BY CITY WARDS)
WARD NUMBERS
Husain Sagar (Tank)
Musi River
Mir Alam Tank
NUMBER OF PERSONS PER SQ. Km.
1,000–5,000
5,001–15,000
15,001
30,001
45,001
60,001
75,000

Figure 5.2'B'

## WARD NUMBERS

2 — CHOROPLETH MAP

HYDERABAD

DENSITY OF POPULATION — 1971

(BY CITY WARDS)

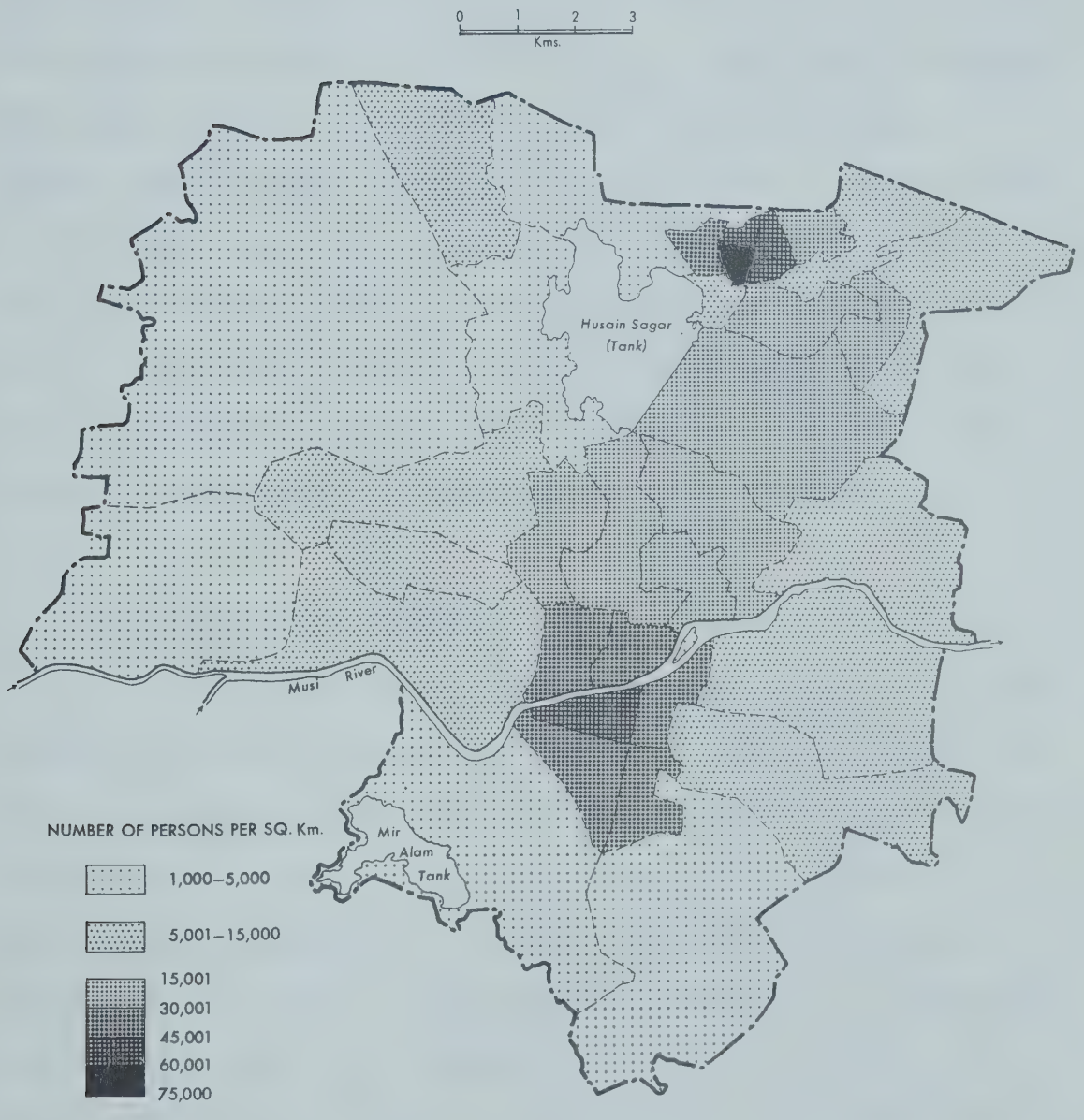



Figure 5.2'B'

has been made.

The disadvantage of this method is that the densities are calculated and the areas symbolized on the basis of administrative units, which means that considerations for inhabitable and uninhabitable areas are not made. In reality, populations are usually not uniformly distributed within each administrative unit as the shading implies. Therefore, there may be as much variation in densities within these areas as there is between them. Hence, this unrealistic representation is regarded as a weakness of this method and it is not used where actual densities have to be visualized. Usually the choropleth method is used for the comprehension of gross densities, as well as variations in densities and land values over a period of time.

### 3. Dasymetric Method

As mentioned in the discussion of the choropleth method of showing population density, each administrative unit is completely symbolized for a specific value without considering inhabited and uninhabited areas. However, in the dasymetric method for showing the same phenomenon, corrections in the data are made on the basis of variations within each unit. For example, the map prepared by the dasymetric method (Figure 5.3A) presents a different delineation of the densities as compared to the same area in Figure 5.3B. These differences have occurred because in

3—DASYMETRIC MAP

# HYDERABAD

(MAJOR PART OF THE CITY)

# DENSITY OF POPULATION — 1971

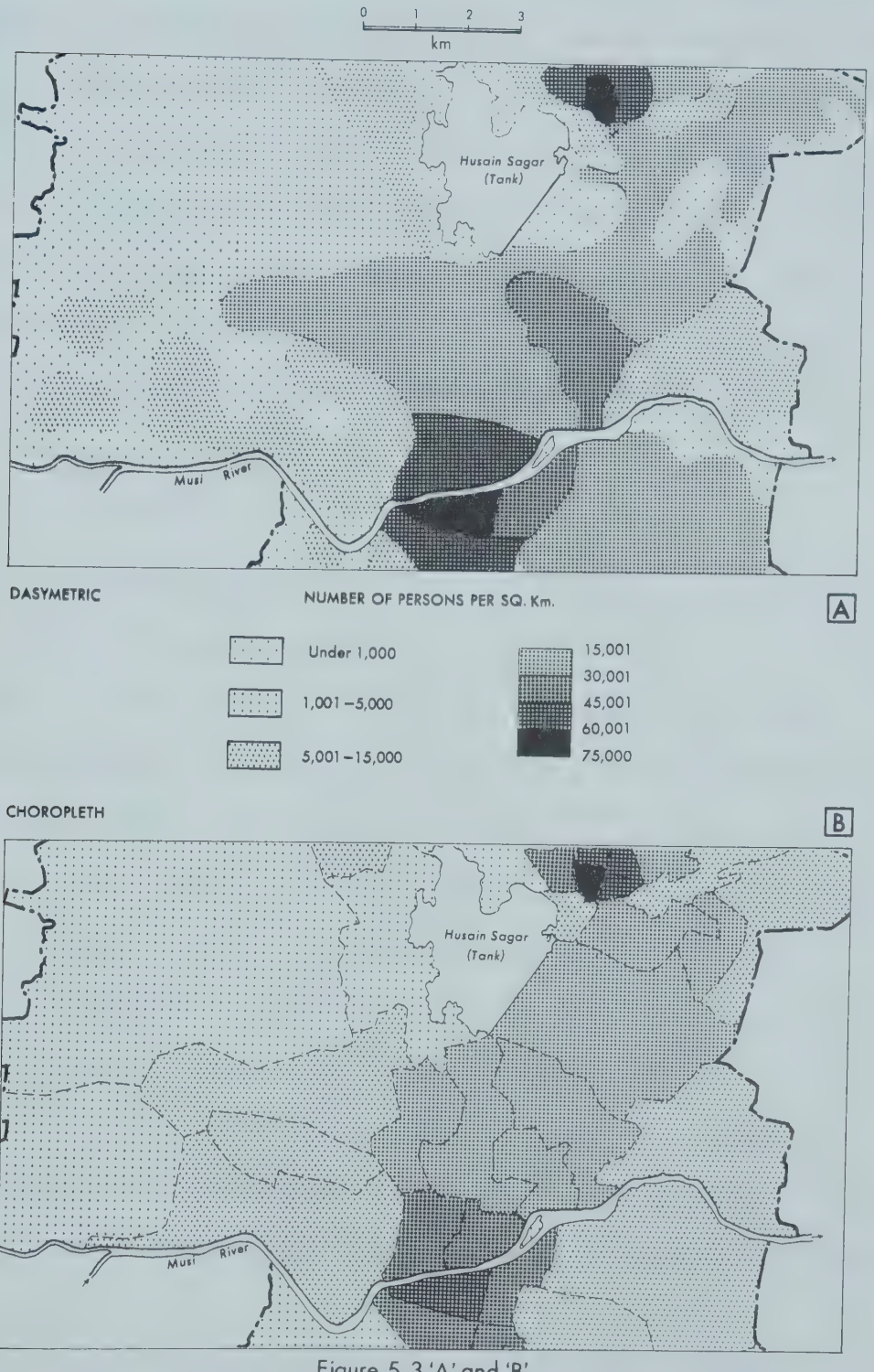



Figure 5.3 'A' and 'B'

the dasymetric method densities are calculated by excluding water bodies, rocky lands and other uninhabited areas. Besides this, areas having similar densities are bounded together, ignoring the administrative-unit boundaries. In this way the densities are more accurately represented. Because of this more useful representation the dasymetric method is considered to be a "refinement of the choropleth method".[1] Usually this method is applied to help the map-user visualize net density patterns which are required primarily in planning and research activities.

4. Dot Method

Populations are usually distributed in a non-regular manner and the patterns vary not only from one city to another, but within a city from one area to another. Dots are therefore the simplest symbol for portraying such distribution patterns. Normally, a varying number of uniform dots are placed on a map, each representing a constant value assigned to it by consideration of the volume of data being represented and the map scale. Dots may be placed on maps in two ways: (1) geographically or (2) geometrically. In the first system, they are placed by consideration of the actual location of the phenomenon. In the second system they are evenly distributed all over

[1] J.J. Klawe. "Population Mapping." The Canadian Cartographer, Vol. 10, No. 1, 1973, p. 47.

an areal unit.

The size and spacing of dots are important determinants of the accuracy of the map. Dahlberg[1] emphasizes this aspect: "The over-all pattern of the dot distribution perceived by the reader obviously depends upon the arrangement and spacing of dots." In this regard it is also important to note that in the placing of dots, cartographers must avoid coalescence so that counting the dots is possible if required for a specific purpose.

In urban mapping, the dot method is frequently used for showing distribution of populations. This method is very simple and has certain advantages; for example, minimal computation is needed to determine the size and value of a dot, as well as the total number of dots required for a map. Besides this, the dots can be easily placed with regard to geographical locations; e.g., avoiding uninhabited areas (Figures 5.4A and 5.4B). By looking at these two maps one can visualize the actual distribution patterns of the populations, as well as the areas of high and low concentrations. In this way, maps prepared through this method can be used for comparing similar phenomena in two different cities like Edmonton and Hyderabad. On multi-colour maps, the composition of a population; i.e., its ethnic, religious, and linguistic groups, can also be shown by adding separate

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[1]Richard E. Dahlberg. "Towards the Improvement of the Dot Map." International Yearbook of Cartography, Vol. 7, 1967, p. 160.

4 — DOT MAP

EDMONTON

# DISTRIBUTION OF POPULATION — 1971

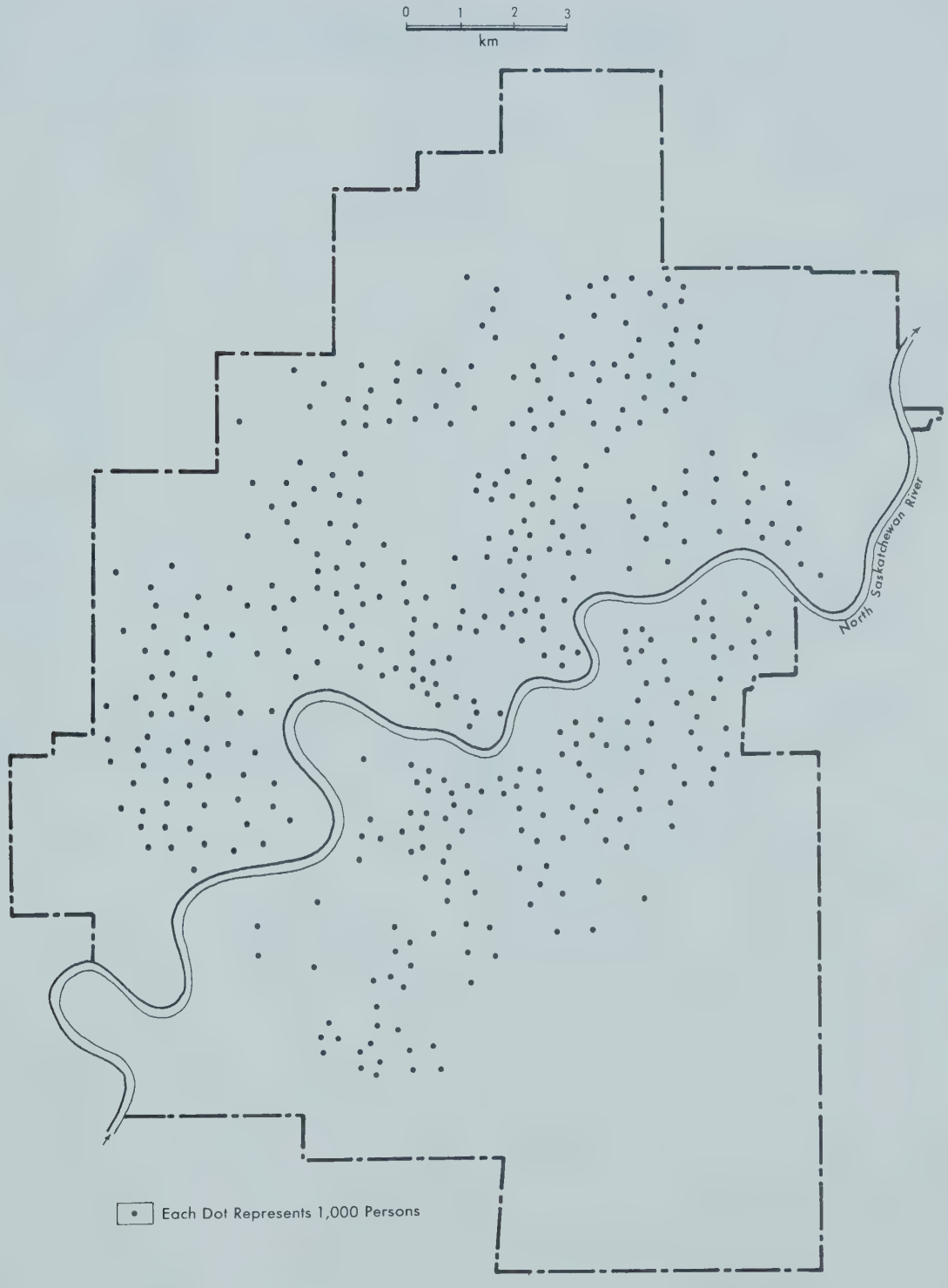


Figure 5.4 'A'

4 — DOT MAP

HYDERABAD

# DISTRIBUTION OF POPULATION — 1971

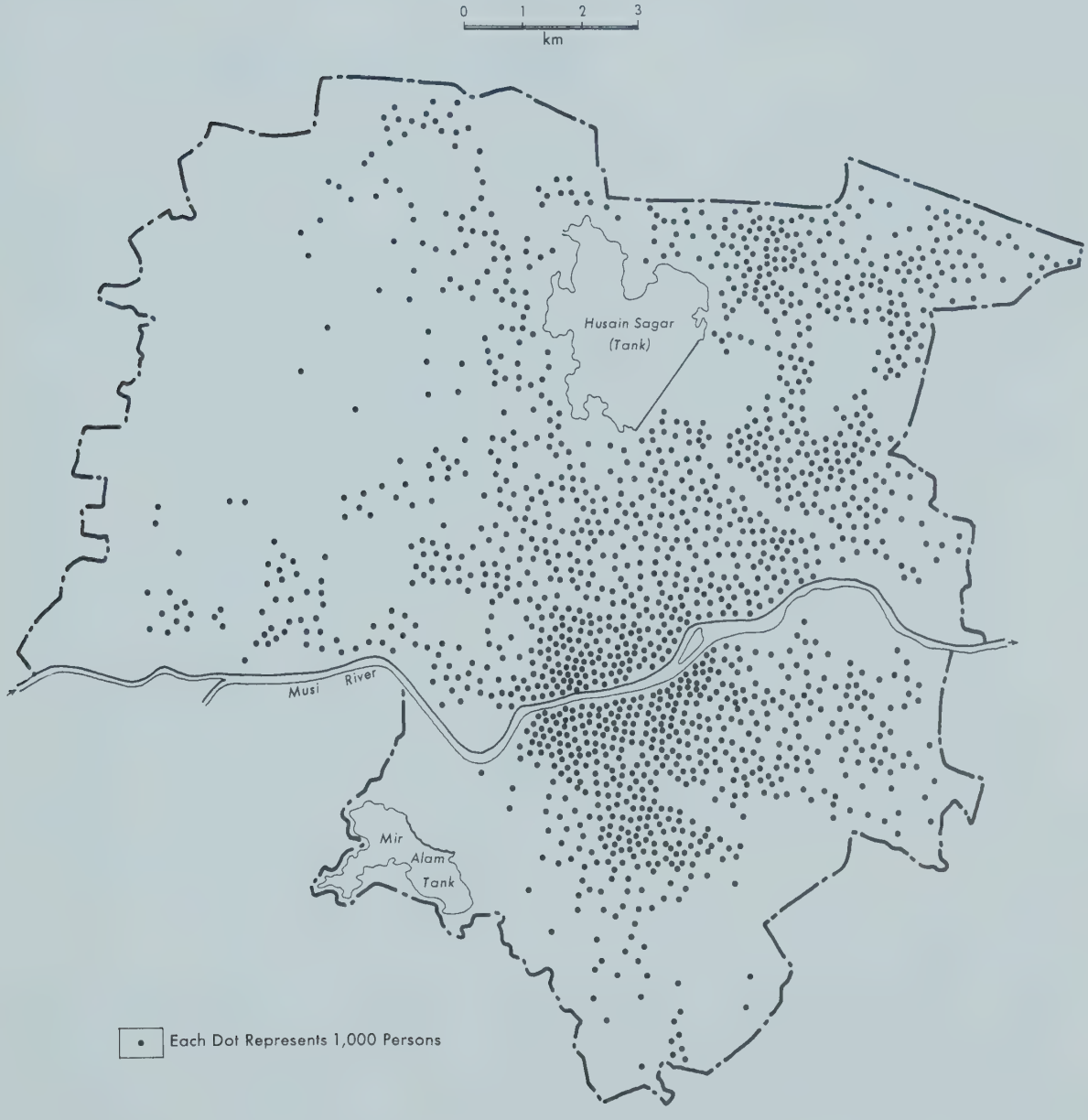


Figure 5.4 'B'

colours to the dots representing each group. Not only can the dots denote the areas of high and low concentrations but the actual population of selected areas can also be determined by counting the dots.

5. Isoline/Isopleth Method

An isopleth is a line which is drawn through locations having the same value of a certain element. An isopleth map is therefore one on which places of equal value are connected with isopleths, and the isopleths, together with the areas, are shown either in black and white or in other colours. The isopleth method has traditionally been used to show differences in continuously distributed phenomena such as surface relief, temperature, rainfall, barometric pressure, etc. The isopleths are called by different names depending on their purpose; for example, if they connect places of equal height (isohypses or contours), temperature (isotherms), rainfall (isohyets), or barometric pressure (isobars).

This method of mapping is used in urban areas to represent non-continuous features such as populations, land values, or travel time. For example, the travel time and distances in Edmonton and Hyderabad (Figures 5.5A and 5.5B) are shown quite effectively by this method. By comparing these maps one can easily understand that the isochrones in Edmonton are more circular than in Hyderabad because of

5 — ISOLINE MAP (ISOCHRONES)

# EDMONTON

# TRAVEL TIME

BY CAR

(IN MINUTES MEASURED FROM CITY CENTRE)

0 1 2 3
km

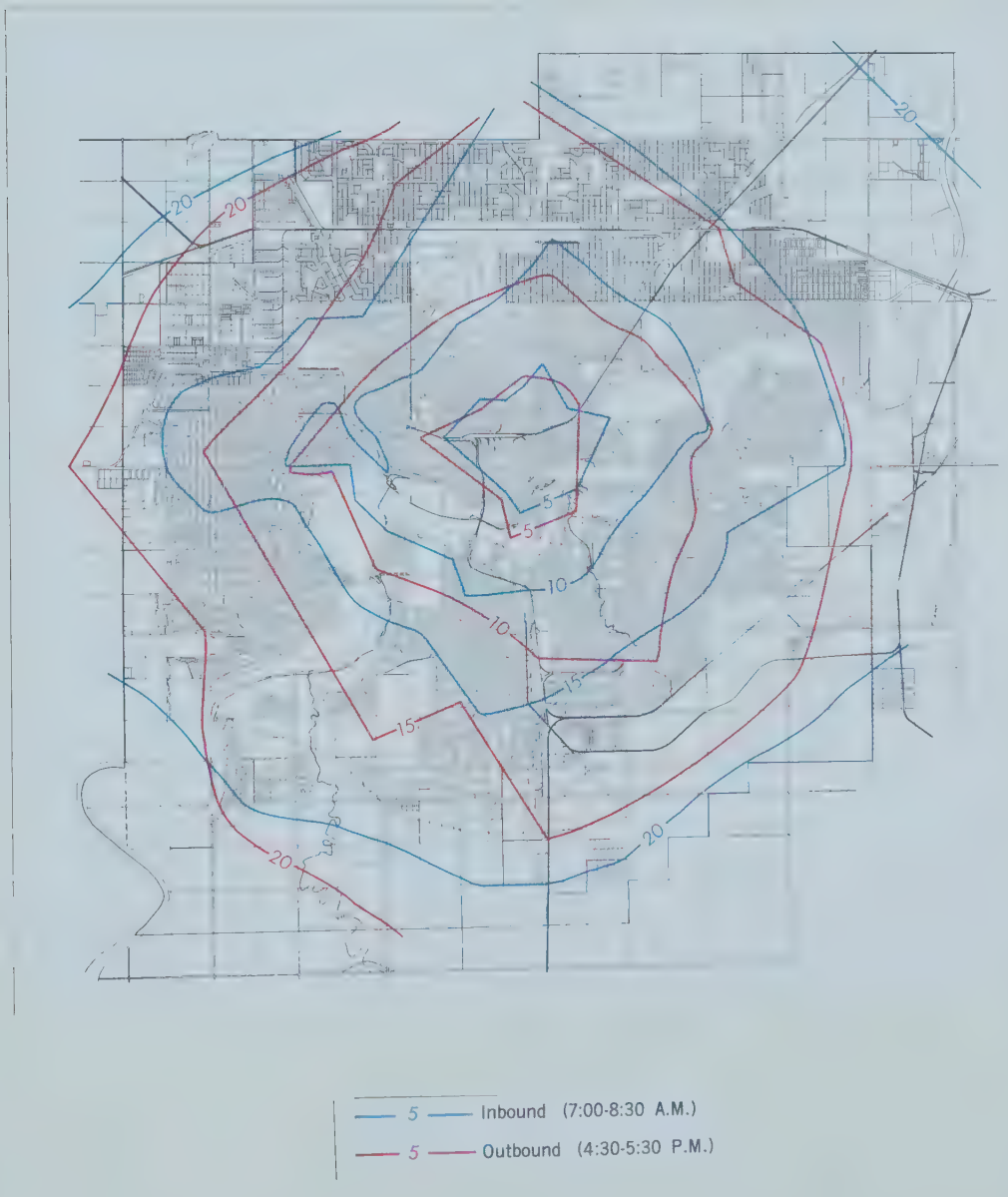


Figure 5.5 'A'

5 — ISOLINE MAP (ISOCHRONES)

## HYDERABAD

# TRAVEL TIME

BY BUS

(IN MINUTES MEASURED FROM RESIDENCY)

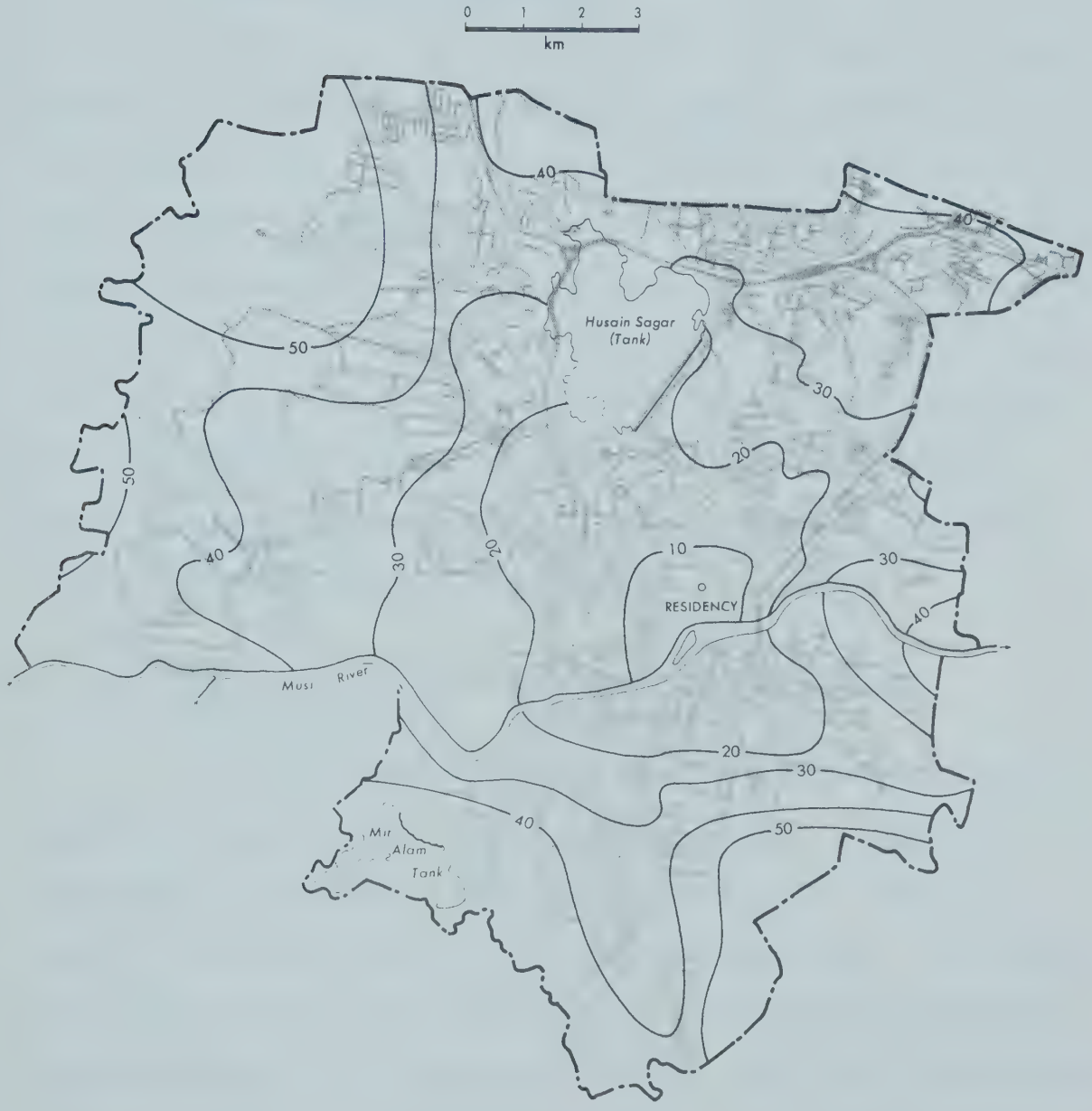


Figure 5.5 'B'

the correspondingly regular and irregular road systems. Isopleths can also be superimposed on base information without causing complications in the background detail.

### 6. Areal or Extent Method

This is a very simple method which shows the areal extent of a particular phenomenon either by an outline or by a colour patch. For example, Figure 5.6 shows the extent of retail commercial areas within the city of Edmonton, using black patches. Similarly, the extent of other land uses such as industrial, residential or recreational, can also be shown. On multi-colour maps, within the area of a specific category such as industrial, the extent of the areas occupied by heavy and light industries can be shown with a variation in the colour tints.

### 7. Symbols Method

In this method data are presented in the form of specific symbols which can be of geometrical, pictorial or alphanumerical design. The symbols method is frequently used in the construction of special-purpose maps. Normally, a few specifically designed symbols are used for portraying different types of information about a particular phenomenon, as in Figure 5.7. Similarly, pictorial or alphanumerical symbols are used for portraying data concerned with cultural or recreational centres.

6 — MAP OF EXTENT

# EDMONTON

# RETAIL COMMERCIAL LAND USE


Figure 5.6

7– MAP OF SYMBOLS

HYDERABAD

# DEGREE COLLEGES AND TECHNICAL INSTITUTIONS

(Within the city and nearby areas, with reference to their management)


Figure 5.7

In order to make a map effective and meaningful, it is important to make a suitable selection of symbols, the form and size of which "depends on the map maker's taste and sense of harmony."[1] Therefore, cartographers need to be quite careful when selecting symbols for specific purposes.

8. Chorochromatic Method

The chorochromatic method is a very simple one in which areas are classified and distinctively symbolized. It is commonly used for depicting spatial distributions such as geology, soil types and, in the case of urban maps, land use patterns (Figure 5.8). The chorochromatic method is also used for showing land values, administrative-unit areas, and location of different groups in a city's population. In this method the use of distinctive colours is necessary to make the map an effective information carrier.

After having dealt with all of the eight cartographic methods it can be said that there are no rigid rules by which any particular method can be applied to a specific phenomenon. Rather, there is ample choice, under which a single phenomenon can be presented by one or more methods, all depending on the volume of data, the knowledge and skill of the cartographer, and the resources available in

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[1] J.K. Wright. "Map Makers are Human. Comments on the Subjective in Maps." Geographical Review, Vol. 32, 1942, p. 542.

8 — CHOROCHROMATIC MAP

# EDMONTON

# LAND USE

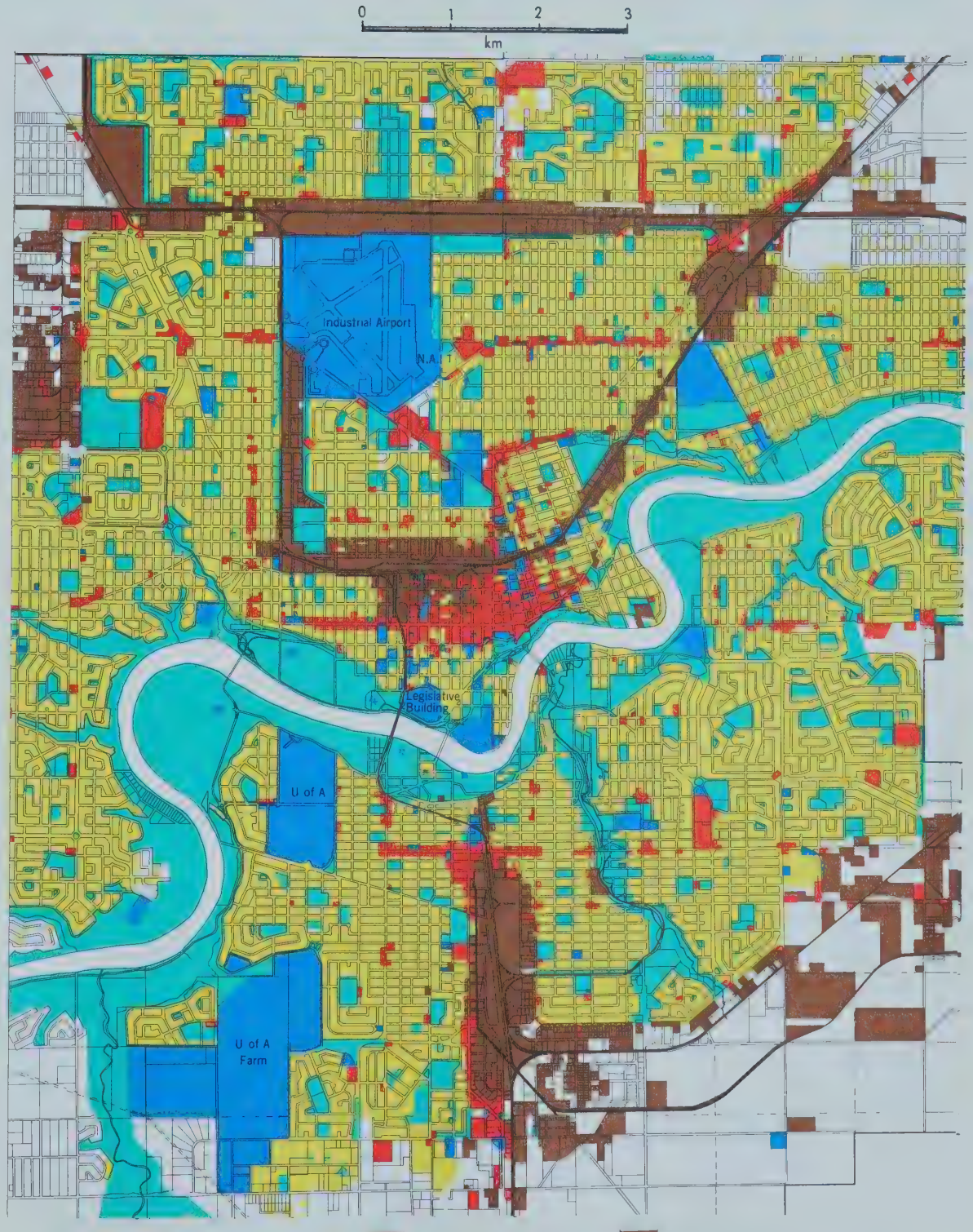


Figure 5.8

the construction and reproduction of a map. Therefore, to make urban maps a valuable means of communication and a useful tool, all types of phenomena need to be presented as suitably, legibly and effectively as the methods allow.

## C. Reproduction of Urban Maps

The objective of map reproduction is to produce multiple copies from the original drawings for specific purposes, either in one or many colours. In the early days copying of maps was a difficult task since "manuscripts were reproduced by copyists who laboriously and slowly duplicated the lettering of the original text, and maps were just another manuscript."[1] It was only in the fifteenth century that printing of maps came into existence, i.e., in Europe. Since that time, there has been significant progress in map reproduction methods as is evident from the quality and number of maps currently available. The reproduction processes are similar for all types of maps, except for the variation in the number of copies required for base maps.

Basically, there are two main stages in the reproduction of maps: (1) Fair Drawing or Scribing, and (2) Printing. In the first stage, maps are drawn on paper or other opaque or translucent base material with pen and ink. Black ink is used on white paper or another base material

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[1] A.H. Robinson. Elements of Cartography. New York: John Wiley & Sons, Inc., 1960, p. 264.

to provide the high contrast necessary for photography or photo-mechanical processes. During the last twenty years draughting has gradually been replaced by a new method called scribing, which will be discussed later in detail.

Maps are either duplicated or printed, the difference being in the number of copies made; that is, a few are duplicated and many are printed. Normally, to duplicate maps, either the blue-print, diazo, xerography, photocopy or lithography process is used because each is easy and economical. A specific process is selected by considering the size of the map, kinds of symbols, number of copies required, and the purpose for which it will be used. For example, the diazo or blueprint process is used to duplicate a map having solid print, line, or area symbols of which just a few copies are required. In the diazo process, copies are made by exposing an original drawing in contact with a sensitized paper and then developing the paper with ammonia fumes. In the blueprint process ferric-salt sensitized paper is used. After being exposed to the light in contact with the original drawing it is developed in water. The significant differences between these two processes are in the image types and in the distortion of the map scales. In the diazo process the image is right-reading positive on a white background; whereas in the blueprint process the image is right-reading negative; i.e., white lines on a blue background. Besides this, there is a greater degree of scale distortion in the blueprint map

than in the diazo because the former is wet-developed and the paper is unstable. Both processes are frequently used to make copies of base maps and construction plans frequently required for urban research and development projects.

Printing of maps is undertaken where many copies are to be made. In printing there are basically three methods: (1) Relief or Letterpress, (2) Intaglio or Engraving, and (3) Planographic printing such as Lithography. Since the early days of printing the lithography process has considerably improved and currently it is known as Offset Photolithography. This is because of its unique indirect image-transferring system in which the image is transferred onto paper through a rubber blanket instead of directly from a printing plate. The main advantage in offset printing is the ease and economy in the preparation of printing plates. Besides this, on some offset machines multi-colour copies can be produced with all colours printed at the same time. Because of all these advantages, offset photolithography has become the most commonly used method of printing maps.

In recent times the introduction of scribing and automation in printing processes has caused significant changes in the traditional map reproduction processes. For example, by scribing on translucent glass or plastic sheets, negatives are made directly from the pencil-drawn manuscripts. In this way scribing has made the fair drawing of maps unnecessary and has eliminated the use of a camera

for the preparation of negatives. In some cases, scribing has also eliminated the need to prepare pencil-drawn manuscripts, particularly when it is adapted directly onto stereo-plotters. Similarly, the introduction of photo type-setting, which has made possible the photo placement of names (as opposed to the previous practice of hand lettering) has considerably improved the quality of maps. In fact, these changes from fair drawing to scribing, from hand lettering to photo-type setting, from mono-colour to multi-colour printing, as well as the increasing automation in various processes, all ensure better results and a speedier reproduction of maps.

Very recently, maps are also being reproduced by computer, but so far this method is in its experimental stage and needs more development to become competitive with the other map reproduction methods.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

### A. Summary

The history of cartography records that the Eskimos of the Arctic and Bedouin of the Arabian Desert were the first people to produce crude maps for locating hunting grounds, dangerous routes and other places of interest. Since then these simple functions of maps have been multiplied and many improvements in the science of map-making have taken place. At present numerous types of maps are produced for a variety of purposes. Besides being a means of communication, most maps are used as tools in the analysis of spatial phenomena, as basic documents and as devices for the storage of information.

In the last few decades the rapid growth of cities and the expansion of urban problems have become topics of vital concern throughout the world. This is because most cities in both the developed and developing regions have become over-crowded and are, therefore, confronted with many urban problems. A few of these problems are scarcity of resources, deterioration in urban con-

ditions, disorder in existing services, and sprawling of city areas. Consequently, urban planning has assumed greater importance than it ever had before. Such planning attempts to promote balanced urban growth through better and more economic use of natural and human resources. Thus in urban planning and research, maps are imperative, not only for the comprehension of urban phenomena, but as tools in the analysis of areas.

Urban mapping, although an old practice, has recently gained in significance because of the role urban maps play in city life as a whole, and more particularly, in urban planning. Urban maps differ from conventional topographic maps in the sense that they carry specific information to suit particular purposes or themes. Also, the compactness and high density of urban areas require a large scale treatment. Finally, rapid change is a characteristic of urban areas thereby necessitating frequent revisions.

The mapping needs of urban specialists, authorities and citizens also vary to a large extent from one user to another. Therefore urban maps contain carefully selected information to suit specific purposes. On the basis of content and the purposes which urban maps serve, they are grouped into three types - base, general purpose and special purpose maps. The main differences among these maps are their scale and the types of information they portray. Usually, general purpose maps are prepared on small scales and carry a considerable amount of information

of interest mainly to the public in general. Special purpose maps are used both by urban authorities and by researchers involved in administrative or planning activities. Base maps have an even more specific use. Their purpose is to create a basis on which specific information can be added for a given investigation. Then, on the basis of these intermediate maps and additional data, final maps are prepared and reproduced.

There are three main stages in the construction of urban maps: (1)Collection of data, i.e., surveying, statistics, etc., (2) Processing of data, and (3) Production of the map. All three stages are important and cartographers must have a thorough knowledge of the means, methods and processes associated with each stage. To make urban maps more useful and to present information most effectively, cartographers should either have a good working knowledge of urban problems or should work under the guidance of urban specialists. Cartographers should be selective when considering cartographic methods to represent a set of statistical data, and choosing the scale as well as projection for a map. They should try to present up-to-date information with suitable cartographic methods in legible and easily understandable fashion.

Although the urban centres examined in this study are located in two different regions of the world, they have a few similarities in their early histories and in their current spatial distributions, such as location

of rivers and location of functional areas. In spite of these similarities, however, and because of the differences in their ages, resources, populations and cultural practices, they exhibit different urban patterns. These variations in urban patterns, when represented by graphic methods, give an immediate indication of the very real underlying differences, particularly the differences in population distribution and density. In this way, cartographic methods are not only effective as they make statistical data visible in graphical form, but they are also useful and efficient in visualizing the variations in the spatial patterns of the two cities.

## B. Conclusions

This study was undertaken with the assumption that the necessary comparable information on Edmonton and Hyderabad would be readily available from such common sources as census publications and other government documents. But in practice, there have been many difficulties, especially in defining the areas of Hyderabad city at different times. As a result, the areas shown are based on approximations. In spite of the fact that the Census of India's publications provide a large amount of information, the city area is not given. Similarly, Canadian census publications do not provide complete comparative information. This is one example only.

In most cases, statistical data have been taken from 1971 census publications. But in the case of Hyderabad, only a few of the census reports are still in print, and even the acquisition of those publications most recently released was delayed because of mail strikes in Canada. Each of these difficulties hampered the progress of this thesis; especially the preparation of maps for the graphic comparison of urban patterns in the two cities. The comparison might have been improved if the types of maps, their different scales, and the number of copies published in both cities could also have been investigated. But due to certain restrictions and financial problems this has not been attempted.

In spite of these obstacles, this study can still be considered a successful attempt to portray several aspects of urban mapping. It throws light on the historical development of urban maps and identifies the various processes and methods involved from the collection of data to the reproduction of maps. This study also demonstrates the efficiency and appropriateness of the cartographic methods which are employed to represent various types of urban data.

In urban mapping eight cartographic methods are frequently used. Often a set of statistical data may be represented by different methods, depending on the purpose and scale of the map and the type of data to be represented. In some cases the choice of alternative methods is limited

because only a few cartographic methods are suitable for the specific type of data. For instance, the dot method is more suitable for showing population distribution patterns, while the choropleth method is more appropriate for portraying gross density patterns. Graphic representation becomes difficult where there is a necessity to keep the same size or pattern of symbols in two city maps on which similar phenomena are being compared. This is especially true where there are considerable differences in the values observed between the two cities. For example, Edmonton and Hyderabad differ greatly in their total populations, areas, and densities, having approximate ratios of 1:4, 1:34 and 1:9, respectively. In such cases the effectiveness of comparative maps depends on the cartographer's skill and his knowledge of the subject matter. However, despite large variations in the statistical data the usefulness of two cartographic methods has been demonstrated here. By retaining the same size and value of a dot in both city maps, the dot method has proven to be effective in the distribution-of-population maps. Similarly, the two density-of-population maps show clearly the high and low density areas in the two cities.

It has been noted here that cities, besides being administrative centres, are also the focus of many other important activities. Therefore, the various types of new, scientifically advanced cartographic devices have been effectively put to use in mapping pursuits adapted for the

collection of planimetric and relief data. Stereo plotters are bing used to prepare manuscripts, drawings, and sophisticated printing machines for the reproduction of maps. Therefore, it is evident that cartographers need to have knowledge of both surveying and photogrammetry and a profound understanding of their functions. They must also be aware of all stages in the construction and reproduction of maps; i.e., to know the new processes and methods being introduced for data collection, for processing, and for the reproduction of maps, since it is important to observe economy at each stage of urban mapping, particularly in the case of available alternatives in the map construction or reproduction process.

During the last few decades some major technological changes have revolutionized the cartographic process as well as changing the actual form of urban maps. Specifically, the introduction of ortho-photo maps has raised the graphic representation to a higher level. Similarly, the introduction of scribing and automation in various map construction and reproduction processes has made it possible to produce maps more quickly.

Most recently, computer-produced maps have come into use, especially in cities of developed regions. As yet they are not popular and are far behind in competing with the traditionally produced, multi-colored, well-designed maps which have a better aesthetic appearance than the computer-produced maps. Nevertheless, these im-

provements should ensure better urban maps in the years to come.

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# APPENDIX 1

## TABLES

Table 1. World Urban Population, 1970-2000
(Projections - Millions)

| | 1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|
| More Developed Countries | 717 | 864 | 1,021 | 1,174 |
| Less Developed Countries | 635 | 990 | 1,496 | 2,155 |
| World Total | 1,352 | 1,854 | 2,517 | 3,327 |

Source: United Nations, Department of Economic and Social Studies, Population Studies No. 49, The World Population Situation in 1970, United Nations, New York, 1971, p. 62.

Table 2. Edmonton and Hyderabad

Urban Populations and Areas - 1901-1971

| | | 1901 | 1911 | 1921 | 1931 | 1941 | 1951 | 1961 | 1971 |
|---|---|---|---|---|---|---|---|---|---|
| EDMONTON | Population | 2,626 | 30,479 | 58,821 | 79,197 | 93,817 | 159,631 | 281,027 | 438,152 |
| | Area $km^2$ | 8.75 | 60.11 | 109.11 | 109.11 | 109.11 | 110.18 | 149.37 | 222.74 |
| HYDERABAD | Population | 448,466 | 502,104 | 405,630 | 447,390 | 720,032 | 1,026,062 | 1,118,553 | 1,607,396 |
| | Area $km^2$ | 81.07 | *81.07 | *81.07 | *89.36 | *93.89 | 143.486 | *155.66 | 169.31 |

Sources:

1. Census of Canada, 1971
2. Census of India, 1971
3. Alam, S. Manzoor, Hyderabad-Secunderabad, A Study in Urban Geography, Bombay, Allied Publishers Pvt. Ltd. (1965, p. 78 and 83).

* Approximates

Table 3. Land Use as % of Built-up Area
Edmonton and Hyderabad

| | Edmonton* | Hyderabad** |
|---|---|---|
| Residential | 31.94 | 42.05 |
| Commercial | 5.28 | 5.40 |
| Public and Semi-Public | 7.78 | 3.45 |
| Industrial | 9.16 | 7.35 |
| Streets, Lanes | 30.56 | 26.30 |
| Parks and Recreation | 15.28 | 15.45 |
| TOTAL | 100.00 | 100.00 |

Source:

*Atlas of Alberta. Government and University of Alberta.

**S. Manzoor Alam, et al. Metropolitan Hyderabad and Its Region. London: Asia Publishing House, 1972.

Table 4. Edmonton

Population and Density - 1971

| Census Tract No. | Population | Density per $km^2$ | Census Tract No. | Population | Density per $km^2$ |
|---|---|---|---|---|---|
| 1 | 3,476 | 310 | 26 | 8,366 | 3,892 |
| 2 | 9,900 | 2,054 | 27 | 7,807 | 4,024 |
| 3 | 6,557 | 2,484 | 28 | 6,893 | 2,714 |
| 4 | 5,297 | 982 | 29 | 7,419 | 2,473 |
| 5 | 2,042 | 152 | 30 | 3,497 | 3,068 |
| 6 | 697 | 128 | 31 | 5,102 | 4,681 |
| 7 | 7,350 | 1,178 | 32 | 7,631 | 6,255 |
| 8 | 4,137 | 2,913 | 33 | 5,165 | 2,460 |
| 9 | 7,704 | 1,834 | 34 | 7,180 | 3,191 |
| 10 | 5,067 | 1,313 | 35 | 4,345 | 2,541 |
| 11 | 6,848 | 3,936 | 36 | 5,302 | 4,078 |
| 12 | 9,812 | 2,788 | 37 | 6,333 | 4,008 |
| 13 | 4,747 | 3,652 | 38 | 5,243 | 3,616 |
| 14 | 5,347 | 3,221 | 39 | 7,893 | 2,498 |
| 15 | 5,541 | 1,498 | 40 | 7,115 | 2,835 |
| 16 | 4,886 | 1,086 | 41 | 6,275 | 2,693 |
| 17 | 4,936 | 3,656 | 42 | 7,658 | 2,188 |
| 18 | 385 | 31 | 43 | 4,046 | 1,736 |
| 19 | 5,628 | 2,415 | 44 | 6,905 | 5,040 |
| 20 | 7,859 | 2,777 | 45 | 3,029 | 4,660 |
| 21 | 6,402 | 4,925 | 46 | 4,786 | 3,682 |
| 22 | 4,387 | 3,538 | 47 | 6,794 | 3,282 |
| 23 | 4,664 | 1,077 | 48 | 4,743 | 4,352 |
| 24 | 4,917 | 2,235 | 49 | 5,369 | 3,335 |
| 25 | 4,667 | 4,282 | 50 | 5,359 | 3,696 |

Table 4, continued:

| Census Tract No. | Population | Density per $km^2$ | Census Tract No. | Population | Density per $km^2$ |
|---|---|---|---|---|---|
| 51 | 4,156 | 649 | 66 | 6,131 | 3,484 |
| 52 | 5,170 | 1,880 | 67 | 6,001 | 2,691 |
| 53 | 5,354 | 4,118 | 68 | 7,320 | 4,044 |
| 54 | 5,370 | 1,647 | 69 | 5,026 | 3,669 |
| 55 | 5,752 | 6,321 | 70 | 6,284 | 3,903 |
| 56 | 5,188 | 4,760 | 71 | 5,786 | 3,594 |
| 57 | 4,255 | 2,251 | 72 | 5,883 | 4,525 |
| 58 | 5,824 | 1,941 | 73 | 5,234 | 3,115 |
| 59 | 8,105 | 2,720 | 74 | 152 | 120 |
| 60 | 8,090 | 2,869 | 75 | 7,638 | 516 |
| 61 | 4,896 | 4,185 | 76 | 7,047 | 2,721 |
| 62 | 4,349 | 1,151 | 77 | 1,892 | 731 |
| 63 | 6,556 | 3,049 | 78 | 4,540 | 194 |
| 64 | 3,585 | 1,488 | 90 | 373 | 12 |
| 65 | 3,687 | 844 | | | |

Source: Census of Canada - 1971. Special Bulletin, Population and Geography. Ottawa: Published by Authority, Statistics Canada.

Table 5. Hyderabad

Population and Density - 1971

| Ward Nos. | Population | Density per $km^2$ | Ward Nos. | Population | Density per $km^2$ |
|---|---|---|---|---|---|
| HYDERABAD | | | | | |
| 1 | 131,219 | 15,842 | 13 | 72,228 | 10,200 |
| 2 | 62,004 | 9,095 | 14 | 64,977 | 43,318 |
| 3 | 81,918 | 29,425 | 15 | 39,574 | 44,818 |
| 4 | 40,526 | 23,603 | 16 | 99,055 | 12,651 |
| 5 | 67,633 | 21,076 | 17 | 88,442 | 13,089 |
| 6 | 49,920 | 4,607 | 18 | 76,476 | 4,814 |
| 7 | 32,283 | 7,559 | 19 | 37,714 | 3,219 |
| 8 | 35,037 | 1,158 | 20 | 63,823 | 40,991 |
| 9 | 35,895 | 3,134 | 21 | 45,939 | 46,450 |
| 10 | 46,649 | 10,902 | 22 | 49,918 | 32,330 |
| 11 | 51,075 | 22,063 | 23 | 53,228 | 47,953 |
| 12 | 31,227 | 10,361 | | | |
| SECUNDERABAD | | | | | |
| I | 27,486 | 3,979 | VII | 15,775 | 49,143 |
| II | 11,611 | 36,398 | VIII | 11,473 | 51,448 |
| III | 7,994 | 47,583 | IX | 13,475 | 17,754 |
| IV | 8,776 | 68,563 | X | 28,892 | 8,627 |
| V | 9,368 | 9,321 | XI | 23,619 | 18,496 |
| VI | 35,658 | 16,725 | XII | 56,509 | 12,872 |

Source: Census of India - 1971. District Census Handbook, Hyderabad District, Parts X-A&B, Village and Town Primary Census Abstract.

# APPENDIX 2

## SOURCES FOR FIGURES

| Figure | Source |
|---|---|
| 2.2 | After George Philip & Sons, "The University Atlas." 1972. |
| 2.5 | After P.J. Smith, "Changing Forms and Patterns in the Cities," and S. Manzoor Alam, "Metropolitan Hyderabad and Its Region." 1972. |
| 3.1 | From Eckhard Unger, "Ancient Babylonian Maps and Plans." Antiquity - 1935. |
| 3.2 | Photograph by The North West Survey Corporation, (Yukon), Edmonton, Alberta, 1974. |
| 3.3 | From the Planning Department, City of Edmonton, Alberta, 1974. |
| 3.4 | From W.H. Bogdan, "Urban Mapping in Alberta, Canada." 1974. |
| 3.5 | From a map by Dianna Dodd, 1968. |
| 3.6 | From W.H. Bogdan, "Urban Mapping in Alberta, Canada." 1974. |
| 3.7 | From "Edmonton Visitors Information Bureau." Alberta, 1976. |
| 3.8 | From W.H. Bogdan, "Urban Mapping in Alberta, Canada." 1974. |
| 4.1 | After Phillip Muehrcke, "Thematic Cartography." A.A.G. Washington, 1972. |
| 4.2 | From Edmonton and Hyderabad, "Tourists Guide Maps." 1974. |
| 4.3 | From Jacques Bertin, "Semiologie Graphique." Mouton & Co., 1969. |
| 4.4 | From Phillip Muehrcke, "Thematic Cartography." A.A.G. Washington, 1972. |
| 5.5'A' | From "Atlas of Alberta." Sheet No. 143, 1969. |
| 5.5'B' | After S. Manzoor Alam, "Metropolitan Hyderabad and Its Region." 1972. |

| Figure | Source |
| --- | --- |
| 5.6 | From a map by Beverly Cook, 1971. |
| 5.8 | From "Atlas of Alberta." Sheet No. 144, 1969. |

Figures not listed above have been compiled by the author.